Institute of Actuaries of Australia

Control, Flexibility and Automation of Actuarial Processes

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Purpose of the Paper

Actuarial teams are increasingly using technology to balance the competing needs of process control and process flexibility and to satisfy Chief Financial Officers demanding more efficient processes and Chief Risk Officers requiring tighter controls. This paper examines two of the approaches that are being adopted to meet these potentially conflicting goals and the benefits and weaknesses of each.

Synopsis

In order to perform regular valuations (including MoS, Capital and Embedded Value calculations), actuarial teams are increasingly required to run complex processes, usually on a monthly basis and in ever shortening timeframes. There is a growing range of requirements placed on these regular processes, which typically fall into the following categories:

- **Balance of Flexibility and Control.** For years (decades?) actuarial departments have sought to remove spreadsheets because of the perception that their flexibility can reduce quality control. However, rapid changes to results are often required to allow for one-off items and changing circumstances and spreadsheets have tended to proliferate within actuarial processes. The challenge for actuarial departments is to develop an environment that is both flexible and yet still provides the necessary control.
- **Robustness.** Key policy level data is often sourced from decades old administration systems. Occasionally data may not be provided, but actuaries are still required to produce monthly or quarterly results. A robust system will need to be able to produce not only the ‘bottom-up’ results based on individual data points, but also ‘top-down’ reasonableness checks that can be used as a temporary alternative if the bottom-up results are unavailable when required.
- **Reasonableness Checking.** In designing a system, consideration should be given not only to producing results, but also to producing supporting outputs that allow users to review and confirm a result with confidence.
- **Removal of Key Person Risk.** Too often actuarial processes include ‘black boxes’ or have substantial ‘manual’ components that are over reliant on key

staff. Ideally, processes will be able to be designed and maintained so that new staff can readily understand and adopt them.

- **Automation.** All too often, too much of the team's time is spent producing results rather than reviewing and communicating them. To the extent that processes can be partially or fully automated, a greater proportion of the team's time can be spent on analysis and communication of results.
- **Reliability of Results.** To the extent that processes are automated, the removal of human error can mean that results become more reliable, particularly if reasonableness checks are also automated.
- **Auditability, Transparency and Documentation.** In order to fulfil audit and best practice requirements, process documentation needs to be complete, detailed and up-to-date with a clear, automated audit trail of changes.
- **Repeatability.** Increasingly it is becoming important to not only explain how specific results were derived, but to be able to reproduce these results so that system flaws in a process can be analysed or differing scenarios modelled on top of prior baselines. In addition, the impact of changes or corrections made earlier in the process can be quickly and automatically fed through to the final results. Today's practices rarely support the reliable and efficient "re-running" of processes to confirm previous results.
- **Reduction in Operational Risk and Capital Charges.** Improvements in the automation of processes within financial organisations should reduce their operational risk. In organisations with an economic capital framework with explicit charges for operational risks, a reduction in these risks through automation should lead to lower capital charges for the relevant department.

Contents

1 Introduction

It is a well documented fact that the work being undertaken by actuaries in financial services has become steadily more complex. These changes have been driven by:

1.1. A series of prudential regulatory changes governing the valuation of liabilities and the calculation of capital as well as changes to international accounting standards for insurers. These include Margin on Services in Australia and Solvency II in Europe. The new regulations generally required actuaries to add new dimensions such as stochasticity or stress testing to their financial modelling.

1.2. Cost pressures, made more severe as a result of the Global Financial Crisis (GFC), are constraining the resources, such as people and technology, available to actuarial departments.

1.3. Whilst the scrutiny of calculations performed by actuaries and others in the financial services industry was already increasing through regulations such as Sarbanes-Oxley, the GFC has served to accelerate the demand for such scrutiny. CEO's and company directors have greater responsibility and accountability for the results reported by the company's CFO, actuaries, accountants and others who report to them. They are demanding greater control, transparency, clarity and traceability in the results being provided to them.

1.4. Regulators, such as APRA in Australia and the FSA in the UK, have reacted to the GFC by increasing their surveillance, enforcement and follow up activity in companies and have increased their staffing levels accordingly.

1.5. Competitive pressures and reporting deadlines from parent companies and stock exchanges (such as the continuous disclosure requirements of the Australian Stock Exchange), have meant that information must be provided by the actuaries in ever shorter timeframes. The impact of these can be quite dramatic, and often mean that reporting deadlines are being cut from weeks and months to days. The substantial reductions in the time available to produce results means that, on occasion, not all the data required to perform the calculations will be available when required, but actuaries are still required to produce the results on time.

Reporting actuaries therefore have a number of potentially conflicting demands being placed on them. Figure 1 below illustrates the relationship between some of these. In this paper, we discuss the impact of the conflicting demands and examine two broad technological approaches being taken to address them. Each approach is assessed on how successfully it meets the demands above. The approaches are not mutually exclusive and we also examine how a combination of the two addresses a number of the issues.

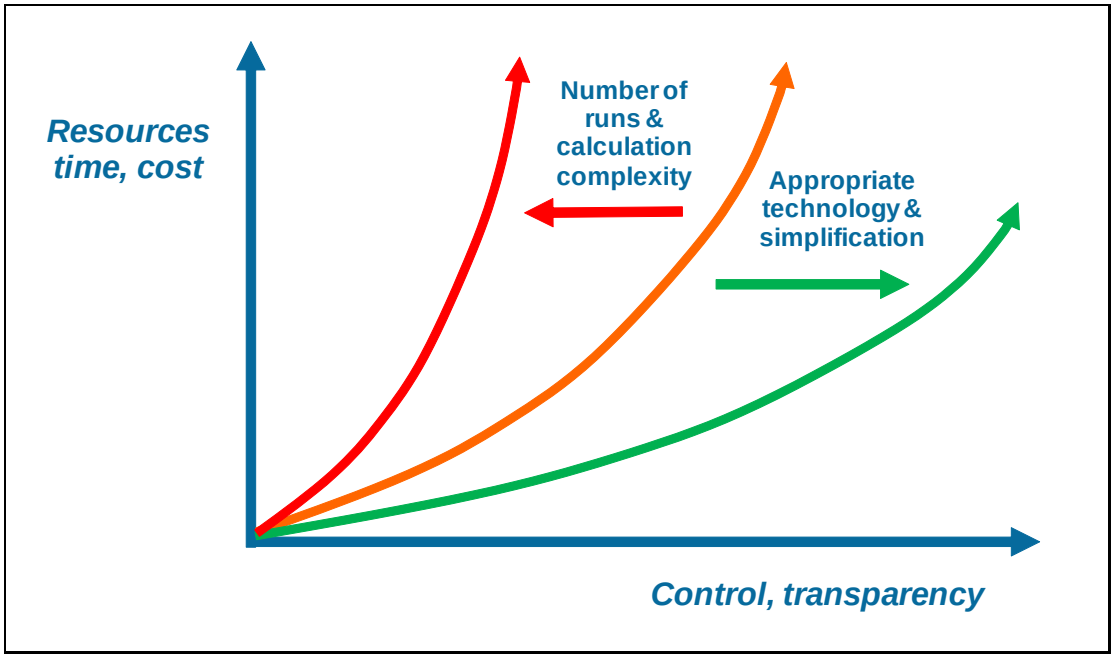

Figure 1: Trade-off between available resources and the level of control. The impact on the curve of added complexity and appropriate technological improvements is also illustrated.

2 Single Data Warehouse Approach

Many insurance companies, both within and outside of Australia, have expressed a desire to build a single, centralised data warehouse to support their analytical (internal and external) reporting requirements for the entire organisation. This is an enticing proposition as it has the potential to enhance control by providing a consistent source of information for all reports to all stakeholders eliminating multiple and possibly conflicting sources of information. To meet the financial, risk and management reporting requirements of an insurer, the data would need to be stored in sufficient

detail to accurately report the financial position of the company, to fully identify the sources of the information and to provide enough information to check combined numbers.

2.1 Benefits of the IT data warehouse approach

There are a number of benefits to be obtained from setting up a single data warehouse for the storage of all the reporting information required by the company. These benefits include:

2.1.1. **Consistency**

Clearly, the most attractive feature of the data warehouse is that it can become the consistent "single source of truth" in the company. All users would access the same data and therefore avoid the costly, all too prevalent issue of different systems (such as administration and accounting systems) providing inconsistent information. Naturally, the organisation would need to ensure that the information being fed into the data warehouse is correct in the first place.

2.1.2. **Efficiency**

A single data warehouse, if properly designed, should provide an efficient mechanism for storing the required information as it eliminates both data duplication and the need for multiple exercises to reconcile the data back to source systems.

2.1.3. **Control**

Data warehouses are normally developed, maintained and supported by a company's IT department. Hence the rigour and control that an IT department normally brings to the development, maintenance and support of core company systems can be relied upon to provide the same level of control over the structure and changes made to the data warehouse and to the use of its supporting tools and processes.

2.1.4. **Ease of access to information**

With suitable reporting tools used in conjunction with modern databases systems, it should be easy to obtain and combine information across one or more of the dimensions in the data warehouse as long as the information has

been stored at a suitably granular level and provided the supporting databases are efficient enough to rapidly supply the information.

2.1.5. **Reduce spreadsheet proliferation**

A data warehouse should make it possible to replace a multitude of spreadsheets and therefore reduce the risks associated with the use of spreadsheets in actuarial functions. These risks are well known but worth repeating. They include:

- **Proliferation.** It is very common for multiple copies of spreadsheets to be created for each valuation and for each run within a valuation. It becomes a logistical challenge for users to organise these spreadsheets and to ensure the appropriate workbook is used each time. Typically these are organised using the file directory structure on a company file server.
- **Invalid links between spreadsheets.** The plethora of copies of spreadsheets and the inevitable approach taken to link spreadsheets within Microsoft's Excel leads to a problem when incorrect data is updated in a target workbook or the update fails to occur. The error or omission may be recognised late in the process and, sometimes, not picked up at all. This represents a substantial operational risk.
- **Lack of version control.** The issue of proliferation can make it difficult for users to be sure that they are using the correct version of a spreadsheet. This can be partially addressed through the use of version control tools such as Microsoft SharePoint for the storage of the spreadsheets.
- **Errors in copying formulae.** Another very common error that occurs when using spreadsheets involves users copying cells where they should not be copied or failing to copy cells to all intended targets. This is a consequence of the inherent nature of spreadsheets where formulae are repeated for each cell in a selected range in contrast to tools that are designed to use a single copy of a formula with a processing loop to repeat the calculation. This is another substantial source of operational risk for companies.

- **Lack of documentation.** Spreadsheet-based and desktop software-based processes are often not documented or the documentation that does exist is often not maintained by the users due to the ease with which spreadsheets can be changed and the time pressures under which users tend to operate. This leads to key person dependency and errors, especially when new staff are required to take over a task.

- **Other user errors.** Many companies use people to perform repeated processes each month or quarter to combine data and results for actuarial reporting. If the spreadsheets and processes are not well organised and clearly defined and monitored, it is easy for even highly skilled people to introduce errors through this manual manipulation of the spreadsheets.

2.1.6. Replace Multiple Systems

In addition to replacing spreadsheets, the data warehouse may replace a number of other custom systems used in conjunction with the actuarial projection systems. These may have been used to manipulate or aggregate data, correct errors or other tasks. These would typically have been written using Visual Basic, Visual FoxPro, SAS or the Prophet DCS tool.

2.2 Weaknesses of the IT data warehouse approach

There are a number of challenges to adopting and implementing a single data warehouse and, to date, few companies have successfully achieved the goal. The reasons for this are as follows:

2.2.1. Design challenges and data complexity

The approach requires companies to carefully design the data store that gathers information from multiple sources such as accounting systems and legacy administration systems with widely differing formats (e.g. gender stored as M or F in one system vs. 1 or 2 in another), using widely differing technologies (e.g. SQL Server databases in one system vs. old proprietary COBOL data formats in another) and widely differing tools available to access the data. The problem is exacerbated in organisations that have been highly

acquisitive and the existence of 5 or more administration systems is not uncommon. It is very difficult to design these databases in a robust manner and with sufficient flexibility to meet the diverse reporting needs of the firm. The speed at which data can be accessed from the databases can also be substantially impacted by the design and it is essential to employ suitably experienced designers for this task.

2.2.2. **Concentration of specification risk**

When organisations enter into large IT projects that take 6 or more months to complete with dozens of participants, they are effectively placing a very large bet that they can specify and communicate precisely what they will need at a future point in time. Mistakes in either the specification or communication of requirements severely impact the cost estimates when a correction is needed 6, 9 or 12 months later.

2.2.3. **Scale and cost of development projects**

Large development projects are usually required to design, build, test and deploy these data warehouses. Often external resources such as actuarial consultants, project managers and IT developers are engaged to provide the specialist knowledge or "manpower" required to undertake such large, one-off development projects. We understand that it took 20 people approximately two years to build such a data warehouse in a large Australian insurer. This equates to a cost in excess of A$10m, excluding the cost of the hardware and software required to support the development and host the resultant databases. Naturally, with projects of this size, there is a substantial risk of cost and time overruns and history shows that it is more common than not that substantial overruns will occur. An actuarial data warehouse (which may be part of an Enterprise Data Warehouse) is typically one of the more complex data warehouses in the organisation and a number of specialists are usually required to develop it. These include actuarial, product, IT and database specialists.

2.2.4. **Cost of ancillary software and integration**

Companies may also purchase "wrappers" for their existing actuarial projection systems. These provide an ability to schedule runs and store versions of the models, the input data and the calculated results in a manner

that means they can be retrieved and re-run if required. Implementation projects will need to include the ability to connect these wrappers to the information in the data warehouse, to read assumptions from it in order to perform the projections and to load the calculated results back into the data warehouse.

2.2.5. **Cost of ongoing maintenance and support**

The development, support, maintenance and provision of infrastructure for such an approach will move from the actuarial department to the IT department of the organisation. It is likely that a number of technologies such as query tools (e.g. Toad or Visual Studio), development tools (e.g. C# or Visual Basic), databases (e.g. SQL Server or Oracle), ETL (Extract/Transform/Load e.g. Microsoft SSIS or Oracle Data Integrator) middleware tools and reporting tools (e.g. Cognos or Business Objects) will be required for the development and use of the data warehouse. These will need to be supported it will be imperative that suitably skilled people are retained for this purpose. It is estimated that a large data warehouse will require 5 or more people with an annual cost of approximately A$1m+ to support the technology alone.

2.2.6. **Volume of data**

The data warehouse can become very large as the information stored typically has multiple dimensions or combinations. These may include the following (along with estimates of the size of each dimension):

- **Purpose of the run** (e.g. Statutory reserve, EV, Capital, ... say 1, if calculations for all purposes are done in the same run. In some companies, separate runs may be required for each purpose).
- **Number of projected cashflows** (e.g. premiums, sums insured, number of policies, etc, say 200).
- **Number of periods in projection** (whilst projections for 600 months are common, this storage dimension may be reduced if fewer months are required in the database and the full set of results is kept elsewhere - so assume 24 months of projected numbers are stored in the database).

- **Valuation month** (e.g. March 2010, say, the current set plus 24 prior monthly sets and another 10 half-yearly sets are retained for historic or taxation-related purposes, equating to 35 sets in total).
- **Interim runs** (assume interim runs are deleted, so say only the final run, i.e. 1, is retained).
- **Number of product lines** (e.g. term business, say 6).
- **Grouped data level** (i.e. the lowest level at which projected results are stored. This must be granular enough to be able to report on all dimensions required for all reporting purposes (such as region and distribution channel). The ultimate level of granularity is at policy or coverage level, but for this purpose we assume companies store the information in 50 groups per product line).
- **Sensitivities, shocks, basis changes, inforce and new business** (these will vary considerably and may not be applied to each valuation period so we assume that on average 30 are stored).

Multiplying these dimensions:

1 x 200 x 24 x 35 x 1 x 6 x 50 x 30 = 1,512 million numbers. This would take at least 12 gigabytes of data storage capacity for the calculated numbers alone. The database keys and indexes used to identify and access the numbers could increase this up to 30 times. In addition, the assumptions used for the projections and historic Profit and Loss and Balance Sheet information would need to be stored to be able to include this information in the reports. Data volumes can also increase when special “materialised views” of the data are created to speed up production of certain reports. A data storage capacity of several terabytes may therefore need to be allowed for.

The size and number of dimensions of the data warehouse can have implications for the speed of accessing information and the complexity involved in managing it as an entity. The overall storage required may also be larger than with other options due to the need to store keys for each dimension. Alternative options may use approaches like file directory trees for some of the dimensions.

2.2.7. **Ongoing tuning**

When a company is working with databases of this magnitude, it is vital that the databases are optimised and tuned on a regular basis. If this is not done, extracting or adding information to the database becomes unacceptably slow. Increasingly, this tuning activity can only be performed by high cost IT specialists. Even under the most lenient of charge-back models, organisations find that the cost of having this level of technical expertise 'on call' significantly adds to the total cost of ownership for the solution.

2.2.8. **Lack of flexibility**

One of the biggest drawbacks of the single data warehouse approach is a lack of flexibility. End users are unlikely to be able to change the databases and systems attached to the data warehouse, particularly if the data warehouse is used by staff outside of the actuarial department. These changes must typically be made by the IT department and must be planned, specified, coded and tested. IT departments usually have long development lists so changes must be prioritised and may not be addressed immediately if the company has more pressing requirements.

Despite the best endeavours of the members of data warehouse development teams, changes will almost certainly be required over time due to the development of new product features or product lines, changes in regulations, the acquisition of new subsidiaries or blocks of business and new management or auditor requirements. A common outcome of the relative inflexibility of data warehouses and the time required to modify them is that end users, such as actuaries, download data from the data warehouse and other sources into spreadsheets and then manipulate the data in those spreadsheets in order to meet deadlines. Whilst such an approach is initially intended to be a stop-gap measure until the data warehouse has been modified to meet new requirements, it is common for these "stop-gap measures" to proliferate over time and become permanent.

As the controls and audit trails revolve around the data warehouse, there are usually few in place to address these "ad-hoc" spreadsheet-based processes that spring up and begin to proliferate. The data warehouse is no longer the "single source of truth" and this gradually degrades the overall control

provided by the data warehouse approach and increases operational risk. This degradation can begin within a year or even before the completion of the data warehouse development project if interim workarounds are used during the development phase to meet deadlines and budgets.

2.2.9. **Time and cost of changes**

Changes to the data warehouse and associated tools take time and incur substantial costs. Due to the need to engage the IT department to plan, specify, code and test changes to the database and associated tools, it may take anywhere from days to months to have changes implemented, even after the changes have reached the top of the IT department's priority list. The cost of each change can be substantial with IT departments commonly charging tens or hundreds of thousands of dollars to effect non-trivial amendments. Whilst the data warehouse development by joint IT and actuarial teams may have taken place with a significant budget and great enthusiasm, it is sometimes difficult to obtain an ongoing commitment to sufficient budgets and sustain interest from personnel in adequately maintaining the data warehouse over time.

3 Spreadsheet-based Automation Approach

3.1 Why spreadsheets are used by actuaries

Whilst spreadsheets have their weaknesses, as listed above, they also have a number of strengths. The main strengths of spreadsheets in an actuarial context are:

3.1.1. **Control is located as close as possible to the subject matter experts**

While often overlooked as a benefit, this is possibly the primary case for spreadsheets and the underlying reason that they are prevalent throughout the industry today. The proximity of expertise and control allows processes to be developed more quickly and iteratively with a lower up-front specification cost as compared to more traditional forms of systems development.

3.1.2. **Flexibility**

It is clear that spreadsheets are very flexible and can easily be modified. They can readily be adapted to accommodate changing circumstances such as when new reports are required or when new data sources need to be incorporated.

The latest versions of spreadsheets such as Microsoft Excel, when used with newer computers, can handle large volumes of data.

3.1.3. **Highly visual interface**

Users of spreadsheets can always see the data they are working with. This makes it easier to find errors and correct them.

3.1.4. **Ease of producing reports and graphs**

It is easy to move data into spreadsheets from a wide variety of sources. Once the data is in a spreadsheet, it is usually easy to combine it in various ways to produce end-user reports and graphs.

3.1.5. **Users do not need IT training**

Most staff in actuarial departments are capable of using spreadsheets without substantial training. They are able to manipulate data, create and modify reports, incorporate new sources of data and perform checks without the need to communicate the requirements to programmers.

3.1.6. **Cost**

Spreadsheets are highly cost-effective with a price tag of a few hundred dollars per user. While they do not offer all the functions of large, centralised systems, their very low cost brings organisations to the realisation that they will achieve “80% of the functionality for 10% of the price”. As organisations continue to look for ways to constrain costs, this increased focus on value *in conjunction with* capability (as opposed to 100% capability first – then cost) is expected to become more common.

3.1.7. **Facilitate communication**

Due to their ubiquity, spreadsheets provide a useful common medium for the communication of data and information within an organisation.

3.1.8. **Supports rapid “what if” thinking**

With spreadsheet-based models and analysis in the hands of the actuary, high skilled resources within an organisation are able to conduct small, low cost ‘experiments’ regarding the way that models are organised and executed. This results in incremental improvements, albeit often “under the radar” and consequently, undervalued.

3.2 Tools to support the use of spreadsheets

Spreadsheets have therefore been used from their very first incarnations for actuarial work. Much more recently, we have seen a number of tools emerging to address the weaknesses of spreadsheets. These tools include:

3.2.1. **Version control tools**

These deal with issues such as proliferation and help to provide audit trails. An example of this type of tool is Microsoft SharePoint. These tools reduce the need to rely on the organisation of files via share server directories, although care is still required to organise the source control tool appropriately.

3.2.2. **Audit tools**

These list or highlight the differences between versions of spreadsheets, identify inconsistencies and highlight links and other "at risk" elements of spreadsheets.

3.2.3. **Automation tools**

These tools provide the ability to automate the steps that users follow when performing various functions. Some of these operate on spreadsheets. Traditionally, macros and Visual Basic for Applications (VBA) code has been used for this purpose, particularly with spreadsheets, but newer tools are available that address a number of deficiencies of macros and Visual Basic code. The deficiencies that are addressed include the need for programming skills, the lack of audit and version controls and the fact that macros are limited to use with certain Microsoft Office products. In addition, some automation products only operate on a single PC at a time and are not multi-user enabled or web-based. More recently, tools are becoming available that create fully documented and auditable, automated processes and work with a wide range of products such as spreadsheets, databases and actuarial systems. They provide a capability to automate the preparation, checking and manipulation of data whether in spreadsheets or other formats whilst also addressing most of the deficiencies of spreadsheets that are listed above.

3.2.4. **Spreadsheet development standards**

The adoption of formalised standards for spreadsheets also helps to address their deficiencies. These standards may include:

- Maintenance of version information and change control lists
- Colour coding and formatting of input, calculation and output cells
- Restrictions on linking spreadsheets
- Protection of calculation sheets and/or cells.

3.3 Benefits of the spreadsheet automation approach

In addition to the strengths and benefits of spreadsheets, by utilising spreadsheet automation systems in an actuarial context, the following benefits become available:

3.3.1. **Processes are documented**

By definition, a process that has been automated has its steps recorded in some manner. Some process automation systems can produce a report that documents the steps in the process as well as listing all the files used in the process and all the dependencies that exist between the steps. As the process is updated or modified, so documentation of the process is modified. Automation keeps actuaries in touch with the steps involved in the actuarial processes for which they have responsibility and satisfies the requirements of auditors and regulators. The use of spreadsheets or other desktop technologies means that the reverse is also the case and process documentation that has been automatically created and kept up-to-date can be used to manually reproduce the steps in a process thus providing component of a business continuity plan.

3.3.2. **Audit trails of changes to processes are available**

Some systems provide reports of the changes made to processes. They identify the individual responsible for the change, the time the change was effected and the nature of the change. Such reports are particularly helpful for supervisors or auditors.

3.3.3. **Audit trails of changes made to files are available**

Similarly, some systems can provide a log of changes made to the underlying data files; either manual changes that are made by a user or automated changes that are programmed by a user but effected by the system itself. This addresses one of the major deficiencies of spreadsheet use where it is common for a significant number of changes to be made without any clear evidence of the route taken to achieve the end result. An important differentiation between

systems with this capability is the extent to which a human (a) can modify the audit trail, and (b) is required to do something to produce a valid and useful audit trial. There is an argument that the ideal audit trail requires no intervention and indeed does not allow human intervention. Not all solutions deliver these audit trail requirements.

3.3.4. **Changes to spreadsheets are automated**

Automation substantially reduces the risk of manual errors made by users simply due to the fact that most of the work is no longer performed by the user. This time saving provides the opportunity for actuarial resources to concentrate on reviewing results instead of running processes and mechanically performing valuations and other repetitive actuarial tasks.

3.3.5. **Location and review of data problems is simplified**

Data used in the actuarial process becomes readily accessible and can easily be viewed at various stages through the process. Therefore, identification of errors and the stage at which errors were introduced into the process is straight forward when compared to locating such data problems in a large enterprise database using specialist tools.

3.3.6. **Flexibility is introduced and rapid changes to processes are made possible**

Automated processes can be managed and maintained by the actuarial department rather than the IT department. As a consequence, involvement of the IT department is substantially reduced and changes to a process can be made by the actuarial department without needing to be prioritised by the IT department. It is also much easier for the actuarial department to make changes to spreadsheets that make allowance for new or changed product features, product lines or data requirements. This does, however, pass the onus of checking for the downstream impact of the changes on to the actuarial department rather than the IT department. Management of the actuarial department will therefore need to ensure that robust change control processes are in place and monitored. These change control processes can be much like those used in IT departments and the IT department should be consulted when setting these up. Controls may include the use of development, test and live

versions of spreadsheets and automated processes and documenting the appropriate approach to migration from one version to another.

3.3.7. **Staged development and deployment is enabled**

Process automation systems can usually be implemented in stages. A large scale development project is normally not required as many existing systems continue to be used with the automation system linking these together. Much of the work can be done by the users of the software and those who are familiar with the processes. It is also feasible to replace portions of processes with new or improved software or tools whilst still preserving the overall process. This approach fits with a software development approach known as Agile (and its philosophy of evolution with small iterations) which is usually more appropriate for knowledge based environments than methods that require the specification of the system in full before development commences.

3.3.8. **Integration of actuarial systems is facilitated**

Some automation systems facilitate the integration of a range of third party systems such as actuarial projection systems, reporting systems, scenario generators and risk aggregators. This obviates the need for substantial development projects to integrate these tools with data sources and other tools required as part of the actuarial process.

3.3.9. **Reliability and robustness are increased**

Naturally, automation of processes should make the processes more reliable. However, this does depend on how the automation has been done. Spreadsheets and data files may need to be reorganised to better suit automation. For example, it is much more difficult to automate spreadsheets with fragmented data that have subtotals inserted between records or multiple tables of data on a single worksheet. Many of the necessary changes will make the spreadsheets easier to maintain and check. Another benefit of reorganising spreadsheets and files for automation is that this activity serves as a catalyst for what is often a long-delayed clean up and simplification, such as the removal of information no longer required. It may no longer be necessary to carry forward historic results in each version of the spreadsheet as the automation system will hold this information. Such cleansing of spreadsheets will naturally reduce the risk of error in the processes that use them. In

addition, once a process has been automated, it is easy to add multiple data validity checks, cross check against separately loaded totals, compare to previous months' calculations, parallel run under different methods and provide the opportunity to configure the process to stop at pre-designated points and await human review and sign-off before continuing with the next stage of the process. These checks are expensive to add to data warehouse systems on an incremental basis but easy to add to spreadsheet automation systems.

3.3.10. **Cost is substantially reduced**

One of the biggest benefits of spreadsheet automation is the low cost of implementation, software and maintenance. When compared to the size of development projects for a data warehouse, process automation systems typically require much smaller development projects and require fewer new software tools (typically only the automation system itself) as existing tools continue to be used. In addition, modifications to processes or data corrections can be made by the user rather than the IT department thereby decreasing communication costs and time delays.

3.3.11. **Key person dependency is reduced**

Many processes in actuarial departments are well understood by only a few people, normally those who carry them out each month or quarter. There are often 100 or more steps involved in these processes and any documentation is often out of date. Companies are therefore very dependent on a few key people for producing their actuarial calculations. By automating these processes, along with the documentation produced, key person dependency can be substantially reduced.

3.3.12. **Simplification and alternative calculations are facilitated**

Automation frees up actuarial resources to investigate alternative or simplified approaches to detailed calculations and these alternatives can readily be tested against the full set of automated calculations. A simplified alternative "top-down" calculation process can be implemented for use when quick approximations are required, as a fallback when the full data set is not available in time for a complete "bottom-up" calculation, or as a check on the results of the full calculation.

3.3.13. **Significant resources are accessible**

Some automation systems provide easy access to substantial computer resources through mechanisms such as “cloud computing”. These resources can include large numbers of computers to perform calculations on multiple CPUs, in parallel, and without the need for the company to purchase the hardware. “Cloud” providers also typically provide considerable data storage capacity at cost effective rates. The reason that such resources can be cost effective for actuarial purposes is due to the fact that the cost is solely determined by the time the resources are used. Therefore if a valuation is run for, say, only two days a month, it may be cheaper to rent the computer CPUs only for those two days rather than own them, house them, maintain them and have them sit idle for most of the month. With cloud computers, it costs much the same to use 200 CPUs for one hour as it does to use 20 computers for 10 hours. This means that actuarial calculations, which are usually well suited to running in parallel, can be completed much more quickly using a larger number of rented cloud computers compared to using, perhaps, a smaller number of dedicated in-house computers for the same cost. It is, however, necessary for the automation software provider to have suitable security structures and load sharing functionality in place to take advantage of cloud computing resources. The cloud computers may also not have the same instant availability that dedicated in-house computers would normally provide.

3.3.14. **Browser-based**

If the automation software can be hosted on the organisation’s intranet or is internet-based, the processes set up by the actuarial team can span several locations. Data can be collected from multiple sources and can be used and reviewed in other locations. This facilitates the operation of decentralised actuarial functions but also helps with the collection and dissemination of information to and from centralised or regional actuarial departments. For example, data can be reviewed in the local insurance operation and errors corrected and then automatically fed into a centralised actuarial projection process and, at the end of the process, the results which are pertinent to the local operation can be sent back to it and made available to the local personnel. In addition, a web-based system will facilitate any requirement for local support.

3.3.15. **Regulatory requirements are addressed**

Some process automation systems allow for the separation of roles, in particular those of development and maintenance of processes vs. the role of running processes. Sophisticated systems also allow for controlled access to information and remove the possibility that production runs can be deleted or modified without an audit trail providing evidence of the deletion or modification. Versions of data and past runs can be maintained or rerun if required. This ensures that processes making use of automation easily comply with regulations such as Solvency II and Sarbanes-Oxley.

3.4 Weaknesses of the spreadsheet automation approach

Actuarial processes that have been automated via process automation systems, like other powerful tools, do not mitigate the need for sound management and adherence to established protocols. Problems can occur if:

3.4.1. **Insufficient time is dedicated to checking spreadsheets**

Spreadsheets are often set up and amended by users unfamiliar with automation. It is therefore vital to ensure that the spreadsheets to be applied to the process are correct and appropriate to the task before the process goes "live". Without adequate checking at the outset, an incorrect spreadsheet could be introduced to the process and re-used each time a process is run.

3.4.2. **Management systems are not in place**

Appropriate management structures must be put in place to review and sign off on changes made to the company's automated processes and the spreadsheets and data structures used with these. Whilst there are tools available to help with managing versions and indentifying changes to the processes and the underlying files used by the processes, these are of little value if managers do not mandate the use of these tools and apply sound version control procedures.

3.4.3. **Adequate data checks are not established**

If processes are not set up with adequate data checks, cross checking of totals and other verification steps throughout each stage of the process, the results

produced by the automated system could be erroneous. One of the key advantages of performing actuarial tasks manually is that users are continuously scanning the numbers and, with experience, can often spot inconsistencies and problems. Manual checks must be replaced with automated checks and the opportunity must be provided for suitably experienced users to check interim and final calculations before they are published. However, if properly done, automation can enable actuaries to spend a much larger proportion of their time on applying their skills to reviewing results rather than “cranking the handle” to produce them.

4 A Hybrid Approach?

It is also feasible to combine process automation systems with the use of a data warehouse. In this scenario the process automation system is used to combine, convert, check and feed the required data into the data warehouse. Data is then drawn from the data warehouse and run through the actuarial systems by the process automation system and the results passed back into the data warehouse. This approach may reduce the cost of developing systems to ensure that clean data is fed into and out of the data warehouse and, at the same time, the data becomes more flexible. To overcome the very significant cost of developing a data warehouse and the inflexibility associated with data warehouses, the design should be kept simple and development should be in stages and be supplemented by spreadsheets controlled through a process automation system. This approach should make it possible to deploy a hybrid approach at a reasonable cost and with sufficient flexibility and control. Hybrid solutions will become increasingly attractive as process automation system providers continue to add tools which enable users to create and modify data bases in a similar controlled manner to other file types such as spreadsheets.

5 Which Approach Should Insurers Adopt?

There are clearly benefits to both approaches and weaknesses inherent in each. Given the cost typically associated with the development and maintenance of a data warehouse, this option may not be viable for smaller insurers. Different organisations will have differing appetites for large scale development projects and differing views

on the need for flexibility. It is important for companies to make their choice bearing in mind the benefits and weaknesses of both options whilst factoring in the skills, available budget. The current IT landscape does offer the opportunity to avoid some of the historical tradeoffs and achieve a "best of both worlds" solution. These solutions are often hybrid solutions that combine the positive elements of each approach.

5.1 Evaluating the options

When evaluating the options available, an organisation should consider the following questions:

- How quickly do we need to respond to changes in our business, i.e. how important is flexibility? How quickly can we change our systems?
- Where in the organisation do we want control to reside for this subject matter? Where does the intellectual capacity for driving our process *really* reside?
- To what extent do we want to rely on human vs. machine effort to create compliance and audit documentation?
- Are we using the time of our subject matter experts and highly skilled staff in the best way? Do we have them doing low-value activities at the cost of higher value activities and analysis?
- Looking ahead over the next several years, do we expect compliance and audit requirements to become more or less stringent? How will we respond to this? How quickly will we need to respond?
- What is the impact on the competitiveness of my organisation and my perceived value as an actuarial professional within this organisation if competitors answer these questions more aggressively and more rapidly than we do?

5.2 Consider relative importance

In answering these questions, the management of the organisation should consider the relative importance of the following factors:

- Flexibility.
- Control.

- Speed in producing results.
- Robustness.
- Versatility.
- Accuracy.
- Transparency.
- Inconvenience.
- Resource constraints.
- IT department ownership.
- Actuarial department ownership.
- Appetite for large scale development.
- Preference for incremental development.
- Upfront expenditure (capital).
- Leasing costs (operational).

In addition, consideration should be given to:

- The ongoing availability of dedicated resources available to maintain and modify a data warehouse and its associated technologies.
- The proliferation of administration and other systems and technologies within the organisation perhaps due to the acquisitive nature of the organisation.
- The need for an interim solution.
- Willingness to use offsite technologies such as cloud computers.
- The company's history with large scale IT development projects.
- Development timeframes.
- Key person dependency.
- The need for auditability and documentation.

6 References

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