Mining Insurance Data to Promote Traffic Safety and Better Match Rates to Risk

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Abstract

Operating or riding in a vehicle is one of the most dangerous things the typical person does on a regular basis. This paper describes how one company is using new technologies and techniques to mine massive amounts of vehicle crash statistics. In 1998, the company invested in new data mart technology that opened the door to more sophisticated analysis of real world insurance claims data by vehicle, by driver, and by geographic area. This paper will discuss the new data mart and illustrate some data mining tools. Four examples will be used to illustrate how the data is being mined to promote safety and better match rates to risk. These include vehicle safety, dangerous intersections, child passenger safety, and teenage driver safety.

Introduction

The CAS Constitution challenges us to advance the body of knowledge of actuarial science. The Actuarial Code of Professional Conduct obligates us to fulfill the profession's responsibility to the public and to uphold the reputation of the actuarial profession. The CAS Statement of Principles Regarding Property and Casualty Ratemaking emphasizes to us how important it is that actuaries derive rates that protect the insurance system's financial soundness and promote equity and availability for insurance consumers. These three objectives are repeated in the ASOP #12 concerning Risk Classification. The purpose of this paper is to expand our actuarial horizons by focusing on using new technologies and techniques to mine massive amounts of insurance data not only to promote financial soundness, equity, and availability but also to promote traffic safety.

Operating or riding in a vehicle is one of the most dangerous things the typical person does on a regular basis. A vehicle crash with injury occurs on average every ten seconds in the United States. More than half of us will be involved in an injurious vehicle crash during our lifetime. Over 3.2 million people are seriously injured or killed every year in vehicle crashes. Over 375,000 children (age 0 to 15) are among those who are killed or injured. Our profession is uniquely positioned with the skills, the data, and new technology that can make a positive difference for the benefit of all society. By embracing new technologies, we can open up opportunities for actuaries not only to better match rates to risks, but also to serve as broader based problem solvers working to reduce risks.

Data Mart Technology

Data is at the heart of nearly everything actuaries do. We desire data that is accurate, appropriate, and comprehensive. As noted in ASOP #23, such data is seldom, if ever, available to our complete satisfaction. No matter how much of this four-letter word we have, we crave more. The good news is, with today's technology, there is no excuse to be data-starved. If you have not recently reinvented your actuarial data base technology, it's time to think again.

In 1998, my company embraced new data technology by investing in a state-of-the-art SP2 data mart. At the time this data mart was built, it was the largest commercial DB2 database parallel processor in the United States. It consists of 130 nodes with sixteen 18.2 GB disk drives per node. There are four processors per node for a total of 520 processors and 2,080 disk drives. This adds up to a total of 37 terabytes of storage capacity. (A terabyte=1,000 gigabytes = 10^12 bytes) It would take a stack of CD's higher than the CN Tower, the world's tallest building, to match the storage capacity of this SP2 technology. Exhibit 1 provides a photo of the data mart.

As of July 2001, this data mart contained roughly 14 terabytes of transaction level data. This includes nearly all policy related and claims related transactions, allowing us the flexibility to slice and dice the data with multivariate analysis in ways that were never before possible.

The following suggestions are drawn from the lessons we learned in the experience of setting up a comprehensive data mart. It is critical that you have an in-depth understanding of the data that will populate your data mart, along with the hardware and software needed to store and process the data. Design your system to be as flexible as possible, plan for growth, and expect frequent changes. Take the time to determine: (1) the specific data elements that you will need, (2) at what point in the business cycle the data will become available, (3) how frequently the data will be refreshed, and (4) the number of years the data will be kept. When selecting data elements, be inclusive yet avoid the urge to include everything except the kitchen sink. Develop a data dictionary that contains the source of the data, the specific coding system, the data edits, and the data validations. Review your data loading procedures to partition data among the disk drives in a way that optimizes the access speeds. Establish rigorous quality control procedures and make sure you comply with privacy laws. Never think you are finished upgrading your system. Appreciate and protect the value of the investment that your company has in its data.

Data Mining Tools

Giving actuaries access to terabytes of detailed data was like putting kids in a candy store. It opened up endless opportunities to do actuarial work that was previously impossible. It has been, by far, the biggest structural change I have seen in my twenty-plus years of actuarial work. At the same time, we faced some major challenges, such as figuring out where to start and what tools to use. It required learning new skills and training our actuarial staff how to access and use the new data mart. As with any change, some have embraced the new technology more quickly than others. Some have merely done what they had previously done in a more efficient manner. Others have been more creative and have realized the power of this technology by doing new and more sophisticated multivariate analyses.

We evaluated numerous tools and decided to use SAS as our primary interface to the DB2 database. Exhibit 2 illustrates the main menu our actuaries use to access the data mart.

Using SAS for the desktop, we created basic lookup programs for frequently used applications. These queries produce common data elements such as exposures, premiums, claim frequency, claim severity, pure premium, expenses, loss ratios, etc. By selecting the desired combinations of states, type of vehicle, coverage, driver class, vehicle, etc. these buttons provide data lookups for many variations. Exhibits 3 and 4 provide illustrations of how actuaries obtain the data for frequently used applications such as limits analysis and loss development triangles. These data queries can be tailored to any combination of attributes and data elements on the data mart.

A very useful technique is to download this data into an EXCEL pivot table. To facilitate this each of these applications has a button programmed for this purpose. Exhibit 5 illustrates how a pivot table was created so that the actuary can quickly analyze how the data elements change for various combinations of variables. Significant correlations and risk relationships can be discovered that were previously not visible using traditional ratemaking techniques.

Two questions encountered in data mining are: (1) how to identify the most significant and predictive risk characteristics and eliminate the insignificant ones and (2) once identified, how to use them in ratemaking procedures.

The term "data mining" is often used to refer to a specific group of computer-intensive techniques (such as neural networks, decision trees, and association rules) which are used to detect patterns and relationships in large volumes of data. In this paper the term is used in a more general way. It is beyond the scope of this paper to discuss the various data mining software on the market or to endorse one over another. However, for purposes of illustration, Exhibit 6 provides a brief summary of the use of the data mart in conjunction with step-wise regression analysis as one way to identify the most significant risk characteristics.

After the most significant risk characteristics are identified, various ratemaking methods can be utilized to match the rates to the risks. It's beyond the scope of this paper to provide an exhaustive discussion of how such methods can utilize the data mart. For illustrative purposes, one such method is to begin with a traditional univariate analysis of the loss ratios for each significant risk characteristic. The initial indicated rate factors are calculated to equalize the loss ratios within that risk characteristic, for example, the age of the principal operator. The univariate analysis is repeated for each of the risk characteristics. The resulting initial rate factors become the seed for an iterative multivariate rate factor analysis that uses the data mart. The premium for every combination of risk characteristics is recomputed using the rating factors for the initial seeds. The loss ratios for each risk characteristic are then recomputed based on the summation of the premiums and losses in the individual cells from the data mart. These loss ratios are used to calculate the next iteration of indicated factors. The iterative process is repeated until the indications stabilize. Exhibit 7 provides an algebraic illustration of how the data mart can be used with this ratemaking procedure.

Putting the Technology to Use

As actuaries doing ratemaking, how many of us are viewed as heartless bearers of bad news about rate increases? Yes, it is important to mine the data to match rates to risk through cost based pricing, but is there more that can be done? The following are four examples of mining massive amounts of insurance data to not only better match rates to risk, but also to promote traffic safety. Each is a work in progress as we continue to refine the analysis and do additional multivariate studies. Each has received considerable attention from the media. [1]

Vehicle Safety

Even though all vehicles are made to meet federal motor vehicle standards, consumers are demanding and manufacturers are delivering advanced safety features. Manufacturers have recognized that "safety sells" and they are attempting to differentiate their vehicle's safety features to promote sales.

The insurance industry has long been very active in promoting vehicle safety. The Insurance Institute for Highway Safety performs crash tests and provides the public with valuable safety information. [2] While crash tests are important, insurance claims data captures how well vehicles perform in the real world laboratory. Insurance data measures the frequency and severity of crashes of all types and medical treatments associated with those crashes.

How well a vehicle performs in the real world depends on how all of the safety features interact in the event of a crash. These include among others the braking systems, the head and belt restraints, the types of airbags, the visibility including daytime running lights and rear brake lights, how well the crumple zones absorb the crash energy, and how well the passenger cage protects the occupants. Overall vehicle safety is not based on these items in isolation, but instead on their interaction during actual crashes.

Effective January 1, 2001, the company implemented a new Vehicle Safety Discount that was based on an analysis of claims experience from millions of crashes. Exhibit 8 provides a summary of the 2000 model year vehicles that qualified for the maximum vehicle safety discount.

The analysis was based on the most recent three years of claims experience by make and model of car. The claims experience was adjusted for distributional bias by using the loss ratio method with adjustments for age and gender related class differences. The experience was then adjusted to recognize fixed expenses. In multivariate analysis, sparsity of data is an important consideration. In accordance with ASOP #25, a credibility procedure was used when a particular model's experience was not fully credible. The standard for full credibility was based on 30,000 vehicles (for 3 years or 10,000 per year). Partial credibility was assigned based on the square root rule. The complement of credibility was assigned to the loss experience for a similar group of vehicles; however, the maximum credibility assigned to any similar grouping was 50%. Any credibility not assigned to the vehicle's claims experience or the similar group's claims experience was assigned to the average for all cars.

An issue from this analysis that received considerable media attention was the vehicle safety ratings by body style. Each body style had some models that qualified for the maximum vehicle safety discount of 40%. Contrary to some of the media coverage, very few SUV models qualified for the maximum vehicle safety discount.

The following table provides a distribution of the vehicle safety discounts applicable to the medical and personal injury protections premiums.

	Vehicle Safety Discounts for 2000 Models		
Body Style	40%	30%	20%
2-door cars	6 models	23 models	51 models
4-door cars	24	22	62
2-wd pickups	5	12	9
4-wd pickups	3	12	8
Station wagons	2	14	4
SUV's	3	30	24
Vans	11	9	11

The feedback we have received from consumers has been very positive and underscores consumers' interest in vehicle safety when purchasing vehicles. Each of the major auto manufacturers has been in contact with us to review the claims experience for the vehicles they produce. This has prompted some very healthy discussions about ways to further improve vehicle safety.

As a brief example, roughly two-thirds of all injuries involve neck sprains and strains. This amounts to billions of dollars of treatments for neck injuries each year. The federal standards for head restraints have not been updated in over 30 years. Some manufacturers have developed safer head restraints that are showing positive results in our data analysis. The National Highway Traffic Safety Administration (NHTSA) is now considering a proposed rule change for head restraints. [3]

Using these data mining techniques we hope to work with manufacturers, NHTSA, and others to promote vehicle safety to reduce injuries in automobile accidents while at the same time better matching rates to risks.

Dangerous Intersections

The screeching of tires, followed by the sound of metal smashing metal, happens on average every 11 seconds at an intersection somewhere in the United States. A significant number of them are deadly. The National Safety Council reported 8,514 fatal crashes at intersections in 1999. [4] Roughly one-third of all injury accidents occur at intersections. Rear-end collisions are the most frequent at intersections because vehicles often are required to stop. Side-impact collisions are also a common event with frontal collisions being less prevalent at intersections.

Taking advantage of our terabytes of data and data mining tools, we sought to identify the most dangerous intersections in the United States and Ontario. Unlike traditional traffic engineering studies, which focus on the number of vehicles passing through intersections, this study mines the insurance data in order to focus on driver behaviors and places greater emphasis on safety-driven solutions to intersection problems. We used the data mining tools to sort through every claim, determining where each one happened, and to add them street by street. Our initial analysis counted all accidents the same, whether they were fatal or just fender-benders. We have now developed a crash severity index that considers two levels of property damage severity and the presence of injuries in the crash. A two-year period (1999 and 2000) was utilized. The claims were adjusted to a common baseline using the company's percentage of vehicles insured by area.

In June 2001 the company released the latest results of this analysis for the ten most crash-prone intersections in the United States. Separate lists were created for 38 states, the District of Columbia, and Ontario. The national top ten list is displayed in Exhibit 9.

The Company offers grants up to $120,000 per intersection to the communities on the national list and up to $20,000 per intersection to municipalities on state lists to fund engineering studies and low-cost improvements. Roughly 100 grants have been issued for approximately $2.4 million in the first phase of this program. The second phase will make another $5 million available for studies and improvements at intersections on the new lists. Some of the recommendations have been as follows:

- Add traffic signals and/or improve location of existing signals
- Install better traffic signal timing to prevent rear-end collisions
- Designate left turn-only lanes and allow only protected left turns
- Improve visibility of signals by making them brighter and larger
- Provide larger street signs
- Give pedestrians more time to cross
- Install skid-resistant pavement
- Improve lighting at intersections
- Relocate driveways that are too close to intersections

It is too early to claim success, but there is early evidence that the number of crashes has been reduced at locations where intersection design improvements were implemented as a result of safety studies we funded. Using these data mining techniques, we hope to work with traffic safety officials and others to make our intersections safer while at the same time providing valuable information in matching rates to risk.

Child Safety

Motor vehicle crashes remain the leading cause of death and disability in the United States for children over the age of one. In an effort to improve this situation, my company has partnered with The Children's Hospital of Philadelphia to do a comprehensive investigation of how and why children are injured or killed in crashes. This study is the largest single research project in the country devoted exclusively to pediatric motor vehicle injury.

Partners for Child Passenger Safety is led by a multidisciplinary research team of internationally recognized experts in medicine, biomechanics, engineering, health education, advocacy and behavioral science. While the study is on-going, preliminary findings have already been published in some prestigious and scientific journals including the Journal of the American Medical Association. [5]

The Partners study is unprecedented in size and scope. The study uses crash database analysis in conjunction with in-depth telephone interviews, near real time on-site crash investigations, and computer crash simulations. The study is examining the entire range of crash and injury severity, from the most minor to the most severe. That helps to explain why children are injured in some crashes but not in others.

The following are some preliminary findings regarding the injuries children are sustaining:

- Sixty-four percent of significant injuries sustained by children are to the head (8% face, 6% neck/back/spine, 8% upper extremity, 6% abdomen, 5% lower extremity, and 3% chest).
- Fifteen percent of children come into contact with something in the vehicle.
- Forty percent made contact with the back of the seat in front of the child (34% with the door, window, or side panel; 20% with broken glass; 15% with a loose object in the vehicle; 13% with the dashboard or windshield; and 13% made contact with another occupant).

The following are some preliminary findings about why children are injured:

- Children not restrained are three times more likely to sustain significant injury
- Eighty-two percent of car seats are being misused in some way ranging from minor misuse such as not being tightly fastened to gross misuse such as not even being attached to the vehicle
- Eighty-three percent of children between the ages of 4 and 8 are inappropriately restrained in adult seat belts
- Sixteen percent of children age 12 and under are inappropriately seated in the vehicle front seat
- Thirty percent of infants are incorrectly turned forward facing in their car seat before age one

Exhibit 10 shows that children in seat belts were 3.5 times more likely to suffer a significant injury in a crash than children in car seats or booster seats. In particular, children in seat belts were 4 times more likely to suffer significant head injury than those in car or booster seats. It is clear that premature graduation to adult seat belts places young children at risk.

There is hope that the Partners for Child Passenger Safety project will produce recommendations that will significantly reduce deaths and injuries to children in auto accidents.

Teenage Drivers

Traffic safety for teenage drivers is a major health problem that has received far too little attention. Automobile crashes are the number one killer of young people between age 15 and 20. Over 6,000 teenagers die every year in traffic accidents and another 600,000 are injured. Per mile traveled, teen drivers have the highest crash risk of any age group.

Our data mart contains valuable information on millions of teenage drivers. We have been able to mine this insurance data in the development and support of programs aimed at the teenage driver problem. In cooperation with the American Driver and Traffic Education Association, we have developed and experimented with a new program aimed at an agent/parent/driver team to focus on gaining experience and having a safe attitude.

The agent/parent/driver team program is called Steer Clear™ and is aimed at two powerful deterrents to auto crashes: experience and attitude. Experience comes with time, practice, and exposure to a variety of driving situations. Attitude comes with being patient, not being aggressive or taking unsafe risks, and not becoming distracted. The program provides a period in which driving is supervised during the safest hours of the day under controlled circumstances, allowing young drivers to gain experience under safer conditions. The program includes an 11-minute video, a magazine, and requires the teen driver to complete a pre-trip and post-trip log for 30 trips of at least 15 minutes each. Supervised trips are also logged by the passenger. The trips are to cover a variety of driving experiences in varying weather conditions including every-day trips to work or school, running errands, social trips with passengers, nighttime trips, dusk/dawn trips, and highway trips. Upon completion of the program there is a quiz and a personal meeting with their insurance agent. Although not mandatory, the program also offers a parent/driver agreement form.

We are carefully mining the data that has come from this experiment. As shown in Exhibit 11, the preliminary results are encouraging. Teenagers completing the Steer Clear program have roughly a 20% better claim frequency at each age level.

Using these data mining techniques, we hope to refine these teenage driver programs to save as many lives and prevent as many injuries as possible. In the process we are providing a ratemaking tool to better match rates to risk as those completing the program receive a substantial discount.

Conclusion

Today's technology provides us better access to data and better data mining tools than ever before. These tools are extremely valuable in our quest to match rates to risk in accordance with our ratemaking principles and standards of practice. However, we can go beyond that to use these tools to promote safety for one of the most dangerous things the typical person does on a regular basis. This paper has discussed how one company is using this technology to mine insurance data to both promote traffic safety and better match rates to risk. Four examples were discussed including vehicle safety, dangerous intersections, child passenger safety, and teenage driver safety.

I hope that this paper has provided helpful information about how technology is changing the way actuaries make rates and has challenged you to find ways in which actuaries can be of further benefit to society as a whole. The value and recognition of our profession will be significantly enhanced if we wisely use our skills, data, and technology to promote financial soundness, equity, availability, and safety.

References

[1.] Major Media Coverage of the Four Analyses

(a) Vehicle Safety

The New York Times carried a front-page story about the new vehicle safety discount on November 28, 2000. Each of the major nightly news networks carried stories about the analysis. It also received coverage in more than 200 media outlets including U.S. News and World Report, Wall Street Journal, Associated Press, National Public Radio, Los Angeles Times, Washington Post, Miami Herald, Dallas Morning News, Boston Herald, Detroit News, and Bloomberg News.

(b) Dangerous Intersections

NBC's "Dateline" covered the Dangerous Intersections analysis in both June 1999 and June 2001. Major stories also appeared both times in USA Today. The analysis received the attention of daily newspapers representing two-thirds of the readership of all of the dailies in the United States. In addition, an estimated 80 million television viewers across the U.S. saw at least a portion of the video news release.

(c) Child Safety

Both the "Today Show" and "Dateline" have featured stories about the analysis. This study of child passenger safety has received coverage in more than 500 media outlets including CNN's Headline News, MSNBC, USA Today, The New York Times, Los Angeles Times, Chicago Tribune, and Parents Magazine.

(d) Teenage Driver Safety

The video portion of the teenage driver safety program has received two awards. Other media coverage has primarily occurred in the two states in which the experiment occurred (Arizona and Maryland).

[2.] The Insurance Institute for Highway Safety, www.hwysafety.org, Vehicle Ratings

[3.] National Highway Traffic and Safety Administration, Federal Motor Vehicle Standard 202, www.nhtsa.dot.gov

[4.] National Safety Council, www.ncs.gov, Injury Facts, 2000 Edition

[5.] Published Research regarding the Partners for Child Passenger Safety Study

(a) "The Danger of Premature Graduation to Seat Belts for Young Children," Pediatrics, June 2000, Volume 105, No. 6

(b) "Factors Influencing Pediatric Injury in Side Impact Collisions," Advancement of Automotive Medicine, October 2000

(c) "The Exposure of Children to Airbags," Advancement of Automotive Medicine, October 2000

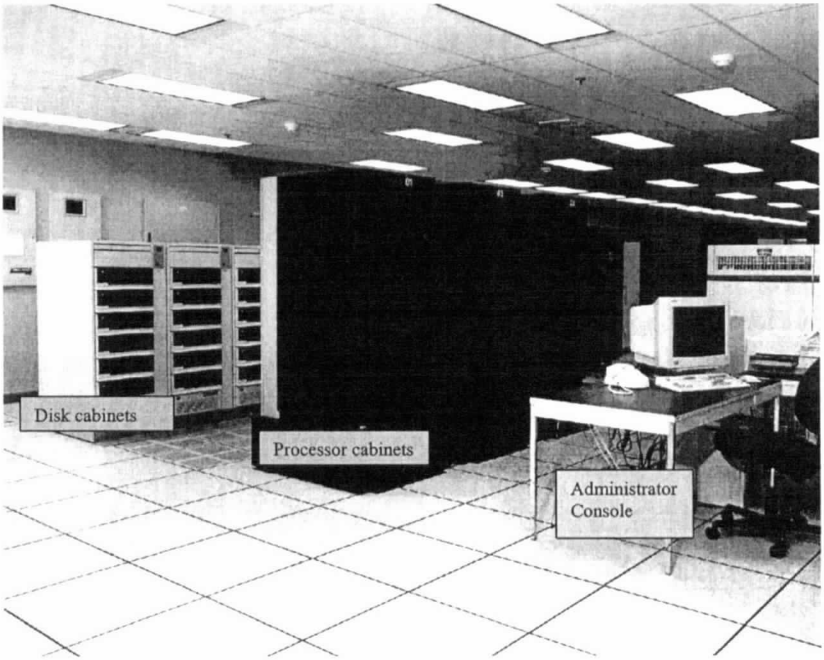
(d) "Misuse of Booster Seats," Injury Prevention, December 2000

(e) "Partners for Child Passenger Safety: A Unique Child-Specific Crash Surveillance System," Accident Analysis & Prevention, May 2001

(f) "Seat Belt Syndrome: A Case Report and Review of the Literature," Pediatric Emergency Care, in press

Exhibit 1

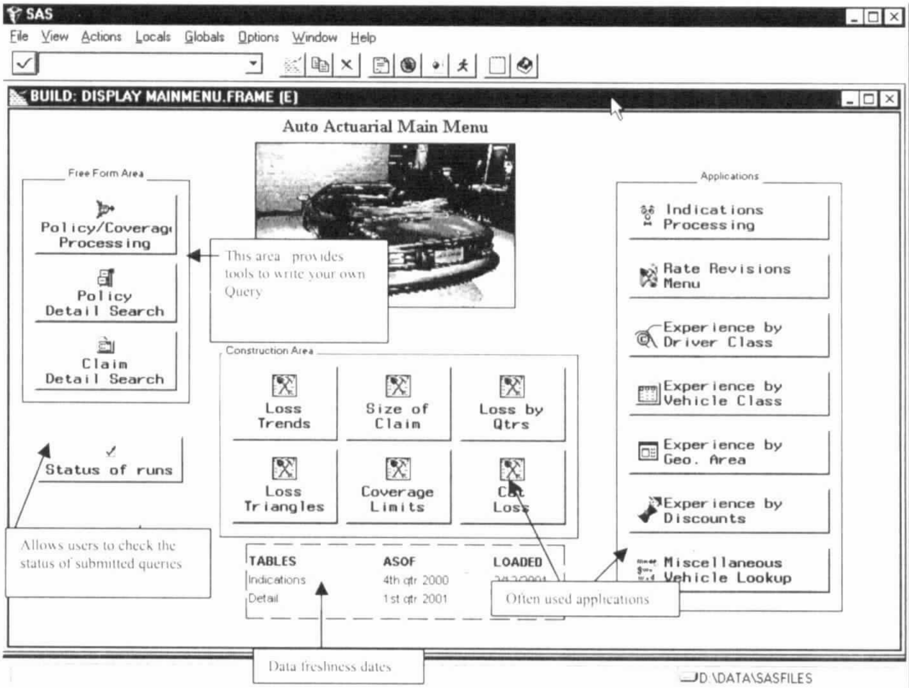
Photo of the Data Mart



This photo shows some of the cabinets that house the processors and disk storage units of the SP2 data mart. Each disk cabinet contains drawers of disc drives where the data is stored. In the event a disk fails, the offending disk can be swapped out and reloaded from a backup, normally with no disruption to the person using the system. The processor cabinets contain the processors, memory, and local disk for the operating system. The processors are grouped into modules for easy access and replacement. A standard RS/6000 workstation is at the center of the SP2 data mart management system. It is the focal point for systems administration. Each actuary's workstation is connected to the data mart through the company's network.

Exhibit 2

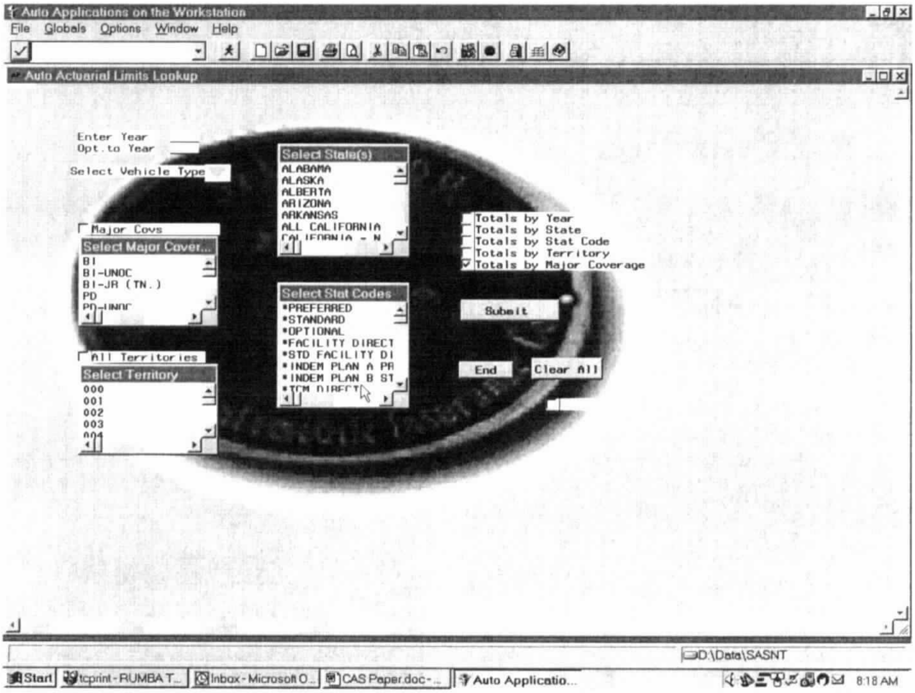
Main Data Mart Menu



This is the main menu that actuaries use to access the data mart. Various buttons have been created to provide the actuary a means to quickly and flexibly download the data needed to do ratemaking analyses and to conduct data mining research.

Exhibit 3

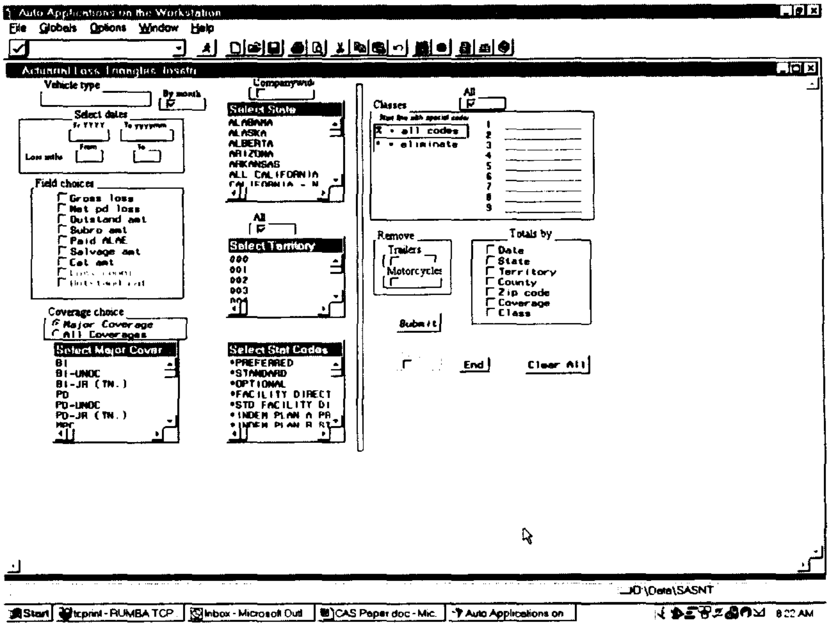
Illustration of the Data Menu for Limits



It is common for actuaries to review data by limit of coverage when doing ratemaking analysis. This menu provides the actuary a means to quickly and flexibly download data from the data mart by limit for various analyses. Similar menus were constructed for other information that is frequently needed for ratemaking such as size of claim, catastrophe experience, age of driver, vehicle usage, accident and conviction records, make and model of vehicle, deductibles, geographic areas, and miscellaneous vehicles.

Exhibit 4

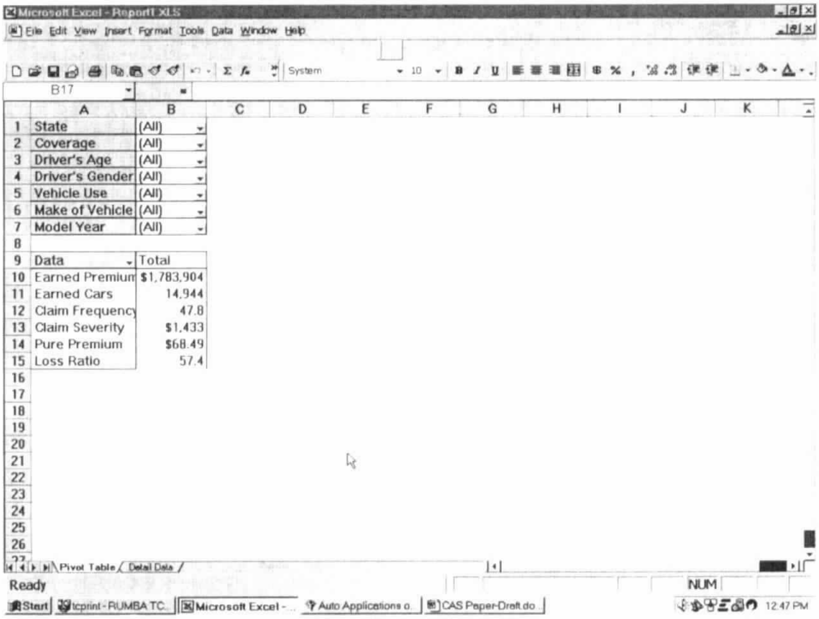
Illustration of the Data Menu for Loss Triangles



It is common for actuaries to sort various claim and claim expense data into loss triangles. This menu provides the actuary a means to quickly and flexibly download data from the data mart for various analyses. Similar menus were constructed for other frequently used ratemaking applications such as premium, loss, and expense trends.

Exhibit 5

Illustration of Using Pivot Tables



This pivot table has been populated with detailed information for seven variables from the data mart. These seven variables are state, coverage, driver's age, driver's gender, vehicle use, make of vehicle, and the model year. These variables can be selected in any combination desired. For example, for the "state" button, the actuary can select a specific state or any combination of states. The same is true for each of the seven variables. Once a selection is made for each of the variables, the pivot table provides six data elements. Any variable or data element in the data mart can be put into this type of pivot table.

This tool is primarily used for exploratory data analysis. It provides a means to quickly sort, filter, and summarize data with the click of a few buttons. The dimensionality and flexibility of the analysis is limited only by the creativeness of the actuary and the credibility of the data.

Identifying Significant Risk Characteristics in the Data Mart, A Step-Wise Regression Approach

Identify the target variable you wish to predict. In identifying significant risk characteristics in an insurance environment, this might be claim frequency, loss ratio, or pure premium.

Transform the target variable in order to facilitate the predictions. When dealing with characteristics and insurance performance of individual exposure units, a large percentage of the observations will have a frequency, loss ratio, or pure premium value of zero. The purpose of this target variable transformation is to make the variable more Normally distributed, and improve the model predictions over the entire range of values. Examples might involve logarithms or roots, for example: (1.00 + square root of loss ratio).

Search the available information about the exposure units loaded onto the data mart - sources might include any available internal insurance statistical data files based upon the company's own data collection, both before and after the risks were insured, as well as demographic information obtained from external sources, and consumer report information.

Explore the available data items for quality and usability as independent variables – consider missing or invalid values, extreme values, and accuracy of coding. Sometimes it helps to review relationships to the target variable based upon univariate analysis.

Develop derived variables that are relationships between two variables or derivatives of single variables. A simple example is that the birth year could be used to derive the age of the applicant during each calendar year.

Derive meaningful intervals for some variables. For example, it might be useful to divide applicants into several different age intervals, instead of keeping all of the different integer values of age. Sometimes this is a good way to deal with missing and extreme values.

In this manner, a pool of candidate risk characteristics (independent variables) is developed. It is not unusual to include hundreds of risk characteristics in the pool of candidates.

Identifying Significant Risk Characteristics in the Data Mart, A Step-Wise Regression Approach

Next, a step-wise multivariate regression analysis might proceed as follows:

All of the candidate variables are tested, and the one which explains the greatest amount of variation in the (transformed) target variable is selected as the first independent variable.

Next, all of the remaining candidate variables are tested, assuming that the first independent variable will also be used. The one that explains the most variation in the target variable, above and beyond what is explained by the first variable alone, is selected as the second variable.

This process is repeated. Tests are performed to determine whether some previously added variables should be deleted, since, for example, two selected independent variables might be highly correlated. Correlations are determined after each step. Various statistical tests are performed to help determine whether each variable is a significant contributor.

Eventually, adding more variables does not significantly improve prediction of the dependent target variable.

An Iterative Multivariate Rate Factor Analysis Procedure

Let X_i = indicated rate factor for the x variable, i^{th} class
Y_j = indicated rate factor for the y variable, j^{th} class
Z_k = indicated rate factor for the z variable, k^{th} class
L_{ijk} = losses in the ijk^{th} cell from the data mart
P_{ijk} = premium in the ijk^{th} cell from the data mart

Note: For ease of illustration, this exhibit assumes a three variable analysis of multiplicative related variables. The process is the same for additional variables and can be modified for other than multiplicative relationships.

In the iterative process:

$$X^1_i = X_i \cdot \frac{\sum_i L_{ijk}}{\sum_i P_{ijk}} \Big/ \frac{\sum_{ijk} L_{ijk}}{\sum_{ijk} P_{ijk}}$$

$$Y^1_j = Y_j \cdot \frac{\sum_j L_{ijk}}{\sum_j P_{ijk}} \Big/ \frac{\sum_{ijk} L_{ijk}}{\sum_{ijk} P_{ijk}}$$

$$Z^1_k = Z_k \cdot \frac{\sum_k L_{ijk}}{\sum_k P_{ijk}} \Big/ \frac{\sum_{ijk} L_{ijk}}{\sum_{ijk} P_{ijk}}$$

Repeat the process replacing X^1_i for X_i, Y^1_j for Y_j, Z^1_k for Z_k and

Replacing P_{ijk} with $P_{ijk} \cdot \frac{X^1_i}{X_i} \cdot \frac{Y^1_j}{Y_j} \cdot \frac{Z^1_k}{Z_k}$

Repeat the process until the indications stabilize.

Exhibit 8

Vehicle Safety Discount

54 Models Received the Maximum Discount for Model Year 2000*

Acura RL 4 door model

Audi A4 4-door model

Audi A6 4-door and Station Wagon

BMW 528i, 540i, 740i, 750i, M5 4 door models

Chevrolet Corvette 2dr and Convertible models

Chevrolet Express 2500 and 3500 Vans

Chevrolet Silverado 2500 4wd pickup

Chevrolet Silverado 3500 2wd and 4wd pickups

Chevrolet Suburban C1500 and K1500 SUV's

Chrysler Town and Country Van

Dodge B2500 Ram Van/Wagon

Dodge Ram 3500 2wd pickup

Ford Econoline E150, E250, and E350 vans

Ford F150 4wd pickup

Ford F250 and F350 2wd pickups

GMC Savana 1500, 2500, and 3500 vans

GMC Sierra 1500 2wd pickup

GMC Yukon XL C1500 SUV

Infiniti Q45 4-door model

Jaguar S-type, VDP, XJ8, XJR 4-door models

Jaguar XK8 and XKR 2-door models

Lexus GS 300, GS 400, and LS 400 4-door models

Mercedes-Benz E320, E430, and E55 AMG 4-door models

Pontiac Montana van

SAAB 9-3 Convertible

SAAB 9-3 and 9-5 4-door models

Volvo C70 Convertible

Volvo S40, S70, and S80 4-door models

Volvo V70 Station Wagon

- **Medical Payments and Personal Injury Protection Coverage Premiums Discounted 40%**

Exhibit 9

Top 10 Most Dangerous Intersections

City/State	Location	Danger Index*
1. Pembroke Pines, Fla.	Flamingo Road and Pines Boulevard	2568
2. Philadelphia, Penn.	Red Lion Road and Roosevelt Boulevard	2317
3. Philadelphia, Penn.	Grant Avenue and Roosevelt Boulevard	2204
4. Phoenix, Ariz.	7th Street and Bell Road	2089
5. Tulsa, Okla.	51st Street and Memorial Drive	2000
6. Tulsa, Okla.	71st Street and Memorial Drive	1995
7. Phoenix, Ariz.	19th Avenue and Northern Avenue	1975
8. Plano, Tex.	State Highway 121 and Preston Road	1937
9. Metairie, La.	Clearview Parkway and Veterans Memorial Boulevard	1925
10. Sacramento, Calif.	Fair Oaks Boulevard and Howe Avenue	1912

*** The danger index is determined by the number of crashes at various intersections, how many of those crashes involved injury, and the severity of those crashes. It is adjusted to account for the percentage of vehicles insured by the Company in areas where the intersections are located.**

Exhibit 10

Child Passenger Safety

Premature Graduation To Seat Belts Places Young Children At Risk

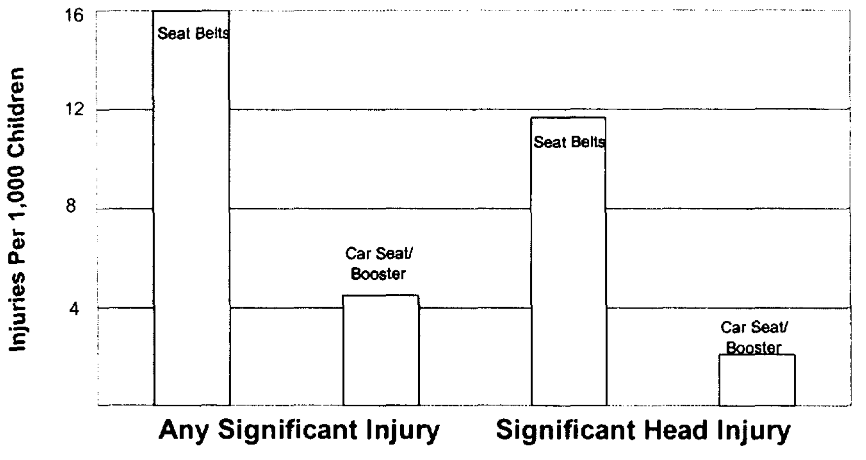


Exhibit 11

Teenage Drivers

Percentage Reduction In Claim Frequency of Those Completing the Steer Clear Program, Among Different Age Categories