

BUSINESS INSIGHT VIDEOS

A Guide for Use with *Business Statistics* by Sharpe, De Veaux, and Velleman

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Business Insight Video 1: Statistics Help Decision Making Under Uncertainty

Summary

This video illustrates how *Deckers Outdoor Corporation* uses statistical models to predict seasonal demand for its various lines of footwear. Based on historical data and past trends, as well as current economic activity and customer behavior, Deckers not only forecasts demand for its large retail customers but also for its online store that carries the entire line for each of its brands. These forecasts drive many decisions, including those dealing with inventory, production scheduling, and even materials acquisition further up Deckers' supply chain. While uncertainty exists, it is important for Deckers' to forecast demand as accurately as possible given the negative cost consequences associated with either over- or under- predicting demand. The main theme of the video is that Deckers' uses statistical models to improve decision making under uncertainty along its supply chain.

Video-Specific Questions

- 1. Deckers Outdoor Corporation, like many of its competitors, sells its footwear online. What types of data does Deckers Outdoor Corporation gather to forecast demand?**

To forecast demand in future seasons, Deckers relies on historical sales data. However, this is dependent on the item being forecast. For example, this works well for carryover items (items carried in the past and will be carried in the future), as historical data are available. If an item is new but similar to an item carried in the past, historical data for the similar item is used to forecast demand for the new item. If the item being forecast is more fashion-forward with no comparable item carried in the past, then historical data from other fashion-forward items carried in the past are used. Information on factors that might influence demand are also gathered, such as consumer trends, competitor offerings, pricing, and general economic conditions.

- 2. What components may be present in historical sales data?**

The four components of time series may be present in Deckers Outdoor Corporation historical sales data. These include trend (long term increase or decrease), seasonal (monthly), cyclical (tied to the economic cycle), and random components.

- 3. What are the consequences of forecasting errors in either direction (over or under) for Deckers Outdoor Corporation?**

If Deckers carries too little inventory, the company faces stock-outs and unhappy customers who can't buy the products they want, potentially affecting customer goodwill.

If Deckers carries too much inventory, the company faces the disposal of unsold footwear at discounted prices. A wrong decision in either direction (too little or too much) has negative cost implications (loss of profit) for Deckers.

4. **Part of the process that Deckers Outdoor Corporation follows in forecasting demand involves revisiting the past year's predictions to see how closely they matched actual sales. What are some measures of forecast accuracy that can be used to do this?**

Some measures of forecast accuracy are the mean squared error (MSE), mean absolute deviation (MAD), and mean absolute percentage error (MAPE). The MSE penalizes large forecast errors because the errors are squared, but it is not in the same units as the data. The MAD is in the same units as the data. So, both MSE and MAD are dependent on the magnitude of the data values. The MAPE provides a percentage that relates the size of the errors to the magnitudes of the data values.

5. **What other decisions, besides those dealing with inventory, depend on Deckers' demand forecasts?**

Deckers' demand forecasts affect decision making up through its supply chain, such as production scheduling and raw materials acquisition.

Relevant Chapters in *Business Statistics* by Sharpe, De Veaux, and Velleman
Chapter 20 (Time Series Analysis)
Chapter 22 (Decision Making and Risk)

Concept-Centered Teaching Points

Payoff tables and decision trees structure decision making (Chapter 22).

Discuss the types of decisions that would have to be made for Deckers' online store. Ask students to think about how a payoff table could be constructed for one of these decisions (e.g., how much inventory to carry for one of its popular brands...UGGs). What are the possible actions? What are the states of nature that impact the decision? How would the outcomes or payoffs be determined? Who might be involved in the decision making process?

Probabilities quantify uncertainty in decision making (Chapter 22).

Extend the discussion started above by considering how probabilities are used in the decision making process. How might the probabilities for the various states of nature be determined? How does historical data on demand factor into the decision making process? Ask students to think about how additional information about the states of nature might be obtained to revise the probability estimates. You can also construct a payoff table with some values proposed by students and calculate the expected value of

each action as well as the standard deviation (which can be used to discuss the topic of risk).

Forecasting relies on past patterns to predict the future (Chapter 20).

The discussion can revolve around the components of time series data (such as those that may be present in the historical sales data used for forecasting at Deckers) such as trend, seasonality, and cycle. It should be noted that extrapolating any of these components into the future for forecasting relies on the assumption that past patterns will continue into the future. This is also a good opportunity to discuss difficulties associated in forecasting the business (or economic) cycle as well as how uncertainty is reflected by the irregular (or random) component of a time series.

Useful Links

<http://cygnus-group.com/CIDM/index.html>

(CIDM = Center for Informed Decision Making)

BUSINESS INSIGHT VIDEOS

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Business Insight Video 2: Variation is Everywhere

Summary

This video illustrates how *Southwest Airlines* must understand the sources of variation that impact flight schedules to better manage its operations. The potential sources of variation that are outside of the airlines' control are identified. In addition, the video shows how Southwest may choose to intentionally introduce variation into flight schedules take advantage of opportunities for its planes to depart the gate early. The main theme of the video is that Southwest Airlines must understand, quantify, and predict variation to assure consistent high-quality service in meeting its customers' needs and expectations.

Video-Specific Questions

1. What are some examples that illustrate the presence of variation?

Stock prices vary based on fluctuating market perceptions of performance, general state of the economy, news releases about the company

The taste of specialty coffee varies depending on the barista's skill, age of the beans, temperature of the roast

The time it takes to complete a transaction at a drive-through bank window varies based on the type of transaction, efficiency of the window teller, number of bank customers in line before you

Downloading speed of a website varies based on type of internet connection, type of computer, complexity of the webpage design

2. What factors contribute to variation in flight schedules for Southwest Airlines?

Many sources of variation that affect turnaround of an aircraft, and therefore flight schedules, are outside of Southwest's control. They include late arriving aircraft, weather conditions, the number of passengers on the aircraft, the number of aircraft on the ground at the same time, and variation in ground crew service and staffing.

3. How can the variation in data be measured?

When dealing with quantitative data, such as the turnaround time of an aircraft, several numerical measures can be used to express variability. These include the range, the interquartile range (IQR), the variance, standard deviation, and coefficient of variation. In addition, visual displays, such as boxplots and histograms, are useful in determining the spread in the data. Frequency and relative frequency tables, pie charts, and bar charts

are also useful in understanding the distribution of values when dealing with categorical data.

4. Can variation be eliminated? Explain.

Variation is inherent in any process. Not every factor affecting a process can be controlled, therefore variation cannot be eliminated. Even in what appears to be relatively well controlled processes, say in production facilities, variation cannot be reduced to zero (although it can be reduced to tolerable levels to assure quality). For example, an automatic process that fills cereal boxes will not fill every box with exactly the same amount. But the variation among contents is small enough to meet the amount specified in the label. Although variation cannot be eliminated, it can be managed. By studying a process, it may be possible to either eliminate sources of variation or reduce their effects. The latter is done at Southwest Airlines. They use the “five minute early push” to intentionally reduce the adverse effects from factors outside their control. When all goes right and turnaround times are faster than expected, flights can depart five minutes earlier than scheduled. Doing this early in the day provides a buffer against falling behind schedule later in the day due to uncontrollable factors such as poor weather conditions.

Relevant Chapters in *Business Statistics* by Sharpe, De Veaux, and Velleman

Chapter 1 (Statistics and Variation)

Chapter 6 (Displaying and Describing Quantitative Data)

Concept-Centered Teaching Points

Variation is inherent in every process (Chapter 1).

Discuss any process and the type of data that might be collected on the process to illustrate how measurements will exhibit variation. Because the theme of the video is transportation, one possibility is to simply ask students to think about the time it will take them to get to each statistics class during the semester. If they were to record these times, would they expect them to be exactly the same? Would the variability in times be the same for each student? If at the end of the semester we were to compare the average travel time among all students in the class, would we be able to conclude that the student with the lowest average travel time was always the first student to get to class? Why or why not?

Effective use of statistics requires understanding variation (Chapter 1).

Extend the discussion started above by visiting the Bureau of Transportation Statistics website (link provided below). As an example, go to the table found at http://www.bts.gov/publications/bts_special_report/2008_009/html/table_11.html titled *Wait Time for Passenger Screening Compared to Expectations 2006 vs. 2007*. Ask students to look at the statistics provided and discuss if there are real differences in passenger responses from 2006 to 2007. For each response category, the percentage and

its margin of error are reported. Without getting into specifics, you can discuss that drawing conclusions using statistics cannot be done by only comparing percentages, but that the margin of error (which is based on variation) must also be taken into account.

Variation can be measured and quantified (Chapter 6).

Even though it is early in the semester, many students are already familiar with some of the simpler measures of variation (e.g., range). This is a good opportunity to talk about how variation can be measured and quantified. As an example, go to the table found at http://www.bts.gov/publications/bts_special_report/2008_008/html/table_01.html. Ask students to compare the variability in average “taxi-in times” for 2007 to 2006. You can discuss the advantages and disadvantages of a measure such as the range, and perhaps give a general overview of other measures that are typically used in statistical analysis.

Useful Links

<http://www.bts.gov>

BUSINESS INSIGHT VIDEOS

A Guide for Use with *Business Statistics* by Sharpe, De Veaux, and Velleman

Business Insight Video 3: Decision Making Error Probability

Summary

This video illustrates how *Norchem Drug Testing* designs its multi-stage testing process to minimize the probability of errors. While two errors are possible in drug testing results (false positives and false negatives), Norchem takes special care to avoid false positives given their serious consequences for an individual. The main theme of the video is that Norchem must understand the types of errors possible in hypothesis testing and design its processes to minimize (or eliminate) their adverse effects in decision making.

Video-Specific Questions

1. What possible errors can occur at Norchem Drug Testing?

Two errors are possible at Norchem Drug Testing: a test result comes back positive when it is not (a false positive) or a test result comes back negative when it is not (a false negative). The goal of Norchem's multi-stage testing process is to minimize the probability of an error in either direction.

2. Which type of error is of greater concern to Norchem Drug Testing?

A false positive is of greater concern than a false negative to Norchem Drug Testing (or any other drug testing company) because of its serious consequences. A false positive drug test means that someone's liberties will be restricted when they shouldn't be (e.g., put in prison, under house arrest, etc.). A false positive leads to false testimony against an individual.

3. Norchem Drug Testing tries to ensure that the probability of a false positive is near zero. What type of probability is this? In the context of hypothesis testing, what would we call this probability?

This probability is a conditional probability. We can state it as the probability that the test will come back positive "given" that the true result is negative. If we assume as the null hypothesis that the individual is not using drugs, then rejecting this when it is true results in a false positive, and within the context of hypothesis a Type I error is committed. In statistics, the probability of making a Type I error is known as α .

4. Give a scenario other than drug testing that is designed to keep the probability of making a Type I error small.

The most well known scenario is the judicial system: presumed innocent until proven guilty. Penalizing someone who is innocent is of greater concern than freeing someone

who is guilty. By using the reasonable doubt threshold, the system is designed to minimize the chance that someone who is innocent is found guilty.

**Relevant Chapter in *Business Statistics* by Sharpe, De Veaux, and Velleman
Chapter 11 (Testing Hypotheses about Proportions)**

Concept-Centered Teaching Points

There are two errors possible in hypothesis testing.

Ask students why we cannot be 100% sure of our decision in hypothesis testing. This is a good opportunity to discuss statistical inference generally and to stress how sample data are used to draw conclusions about population parameters (the reason why we can never be 100% certain about our results). Discuss the two types of errors possible in hypothesis testing: Type I and Type II errors. A Type I error occurs when we mistakenly reject a null hypothesis that is true and a Type II error occurs when we mistakenly fail to reject a null hypothesis that is false.

The level of significance (α).

What is the level of significance (α) in hypothesis testing? Discuss how it is the probability of making a Type I error (rejecting the null hypothesis when it is true). In hypothesis testing we want to control the probability of making a Type I error, therefore we specify α as a very small value such as 0.01, 0.05, or 0.10. The typical α value is 0.05. This is a good opportunity to also discuss rejection regions, the sampling distribution of the test statistic under the assumption that the null hypothesis is true, and the unlikely possibility of obtaining a test statistic value in the rejection region when the null hypothesis is true.

The p -value.

What is the p -value in hypothesis testing? Stress that like α , the p -value is a probability, but that this probability is associated with the value of the test statistic obtained from the data while α is predetermined by the investigator. Specifically, the p -value shows how likely it is to observe the test statistic value given that the null hypothesis is true. Therefore, small values indicate that it is not very likely. Ask students how unlikely is unlikely enough for us to reject the null hypothesis. Then you can discuss how the decision is made by comparing the p -value to α .

Useful Links

https://www.norchemlab.com/main/drug_references/mythbusters1.pl

BUSINESS INSIGHT VIDEOS

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Business Insight Video 4: Models Are Not Reality (But Can Be Incredibly Useful)

Summary

This video illustrates how *Starwood Hotels and Resorts* must rely on complex statistical models to predict future redemptions of earned points in its Starwood Preferred Guest program. Although not perfect representations of reality, these models are used to forecast the worth of future redemptions for reporting to the SEC and IRS, as well as for planning at Starwood. The models take into account historical point redemption patterns by tier, travel trends, and changing economic conditions and are continuously adjusted to improve forecast accuracy. The main theme of the video is that these models for predicting future earned point redemptions, while not reality, are invaluable to Starwood's reporting and planning processes.

Video-Specific Questions

1. For what purpose does Starwood Hotels and Resorts use a statistical model?

Starwood Hotels and Resorts uses a statistical model to determine the value of earned points that will be redeemed in its Starwood Preferred Guest program. It must be listed as a liability on the company's balance sheet. The model is used to predict future redemption of points.

2. What statistical model(s) might be appropriate for Starwood's situation?

Multiple regression may be an appropriate methodology for developing Starwood's model if a number of independent variables are considered to affect point redemption. Another possibility is to use a forecasting method that extrapolates historical point redemption patterns into the future.

3. What might be plausible variables to include in the model? What may be some potential sources of uncertainty?

Historical data on point redemption is an important input to the model. Starwood keeps track of how members of the program redeem their points by tier because members in higher tiers tend to redeem more points than those in lower tiers. Consequently, dummy variables coded to represent different tier levels could be included. Potential sources of uncertainty are changing travel trends and general economic conditions.

4. Describe the process by which Starwood Hotels and Resorts seeks to improve the accuracy of the model.

The model is not reality. It is important that Starwood compare the model's predictions to actual point redemptions. As guests redeem their points, the liability on Starwood's financial statements is reduced and a pre-determined payment is made to the property as compensation for the point redemption. These data are collected and used to analyze the predictive accuracy of the model. Over time the model can be adjusted to improve accuracy.

Relevant Chapters in *Business Statistics* by Sharpe, De Veaux, and Velleman
Chapter 18 (Multiple Regression)
Chapter 20 (Time Series Analysis)

Concept-Centered Teaching Points

Multiple regression models are not deterministic (Chapter 18).

This is a good opportunity to discuss how regression (statistical) models are stochastic (probabilistic) rather than deterministic. Give an example of a deterministic model (such as determining a salesperson's commission) and contrast it with a multiple regression model that includes uncertainty (like the one that could be used for Starwood Hotels and Resorts). Ask students how uncertainty is represented in a regression model. Why can't a regression model explain 100% of the variation in the dependent variable? What goes into the "error" term?

Correctly interpreting multiple regression results (Chapter 18).

You can refer to standard multiple regression output for an example and ask students questions about interpreting the results. What measure is used to determine how much variability in the dependent variable is explained by the multiple regression model? What are reasonable values for R^2 in practice? How should multiple regression coefficients be interpreted? What does it mean when a multiple regression model is significant? What does it mean when the regression coefficient for an independent variable is significant?

Multiple regression-based forecasting models for time series (Chapter 20).

This is a good opportunity to discuss regression-based forecasting models. Ask students to think about how multiple regression models can be used with time series data. How can the model capture trend? How can seasonality be represented in the model? Discuss the coding of dummy (or indicator) variables. What are some potential problems of using multiple regression with time series data? Discuss the issue of autocorrelation and the use of the Durbin-Watson statistic.

Useful Links

<http://forecasters.org/internet-sites.html>

BUSINESS INSIGHT VIDEOS

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Business Insight Video 5: Graphing and Exploring Data Can Reveal “Eurekas”

Summary

This video illustrates how *Autoliv* uses graphs and charts to understand quality-related data collected from its production processes. Its goal, to assure quality for its customers, relies on identifying and correcting any process problems before defective parts are produced. By graphing data collected from samples of custom steering wheel parts produced in an injection-molding process, Autoliv discovers that one of the mold cavities yields a mean weight for these parts that is off the target specification. This “eureka” enables Autoliv to take corrective action on the process preventing any unacceptable parts from reaching its customers. The main theme of the video is that by using graphs to understand its process data, Autoliv is able to find and correct process problems that would have otherwise gone undetected and may have resulted in dissatisfied customers.

Video-Specific Questions

- 1. For what purpose does Autoliv collect data? Give some of examples of the types of data collected.**

Autoliv collects data routinely on every aspect of its operation to assure quality. Like many other companies, Autoliv is interested in improving products and processes, streamlining operations, and reducing costs. The company wants to find deviations from target as soon as possible so that it can identify the problem in the process and correct it to prevent producing defective parts. Autoliv produces custom steering wheel parts using an injection-molding process. Autoliv collects both qualitative and quantitative data for compliance with design specifications. Gloss and color are examples of qualitative data; weight and tear seam thickness are examples of quantitative data.

- 2. Explain why Autoliv must rely on sampling for data collection.**

Rather than testing every part manufactured, Autoliv relies on sampling. Sampling is obviously more time and cost effective. In addition, at Autoliv and in many other companies, the quality testing required may actually destroy the product. When destructive testing is involved, it is not feasible to test (and therefore scrap) every part produced in the process.

- 3. What types of graphs / charts can Autoliv use to explore the data?**

Histograms, boxplots, and control charts can be used to understand Autoliv’s process data.

4. Describe how the “eureka” revealed to Autoliv in the film was discovered.

Autoliv discovered that steering wheel parts from the injection molding process differed in weight depending on the cavity used for molding. By understanding its process, Autoliv was able to see that the mean weight of parts produced using one of the cavities was off the target. This also required knowledge of the spread (variability) in weight values. Charting made it possible to see the difference between the mean weights of parts produced by the two cavities.

Relevant Chapters in *Business Statistics* by Sharpe, De Veaux, and Velleman
Chapter 6 (Displaying and Describing Quantitative Data)
Chapter 25 (Quality Control)

Concept-Centered Teaching Points

The five-number summary and boxplot are used to explore data (Chapter 6).

Ask students to give some summary measures for quantitative data. Record those that are part of the five-number summary (minimum value, first quartile, median, third quartile, maximum value). Why are these measures useful for exploring data? What can we learn from these measures? Discuss how these five values can be displayed in graphical form on a boxplot. Discuss the usefulness of boxplots for seeing the spread of a data set, determining if the data set is symmetric, and identifying outliers. Note that it is easy to construct multiple boxplots on the same scale to compare different data sets.

Histograms are useful for understanding quantitative data (Chapter 6).

Histograms are one of the most popular tools for understanding data that are quantitative and continuous. Discuss how histograms are constructed. Ask students to think about why histograms are so useful. Stress that along with center and spread, we can use histograms to determine the shape of a distribution (e.g., unimodal, bimodal, symmetric, or skewed) as well as to detect outliers.

The structure and purpose of control charts (Chapter 25).

Control charts are arguably the most important tools in statistical process control. Discuss the basic construction of control charts (centerline, upper and lower control limits). While there are many types of control charts (attributes and variables), discuss the basic idea of using these charts to find “out of control” points. Using Autoliv to provide context, you can talk about how samples (subgroups) are selected periodically from a process and some quality characteristic (e.g., weight) is measured for each item in the sample. Then subgroup statistics are calculated (e.g., mean and standard deviation) and plotted on control charts. A subgroup statistic that falls outside the control limits is very unlikely, so it is considered an “out of control” point. Stress that the purpose of control charts is to both stabilize and improve processes.

Useful Links

<http://www.asq.org/learn-about-quality/data-collection-analysis-tools/overview/histogram.html>

<http://www.asq.org/learn-about-quality/data-collection-analysis-tools/overview/control-chart.html>

BUSINESS INSIGHT VIDEOS

A Guide for Use with *Business Statistics* by Sharpe, De Veaux, and Velleman

Business Insight Video 6: Quantifying Uncertainty in Making Estimates

Summary

This video illustrates how *McDonald's* collects data to estimate its drive-through service time. Not only is measuring variability key to quantifying the uncertainty surrounding this estimate, but it provides McDonald's with information about the consistency of its drive-through service and opportunities for improvement. By understanding the sources of variability in their drive-through service times, McDonald's can make changes to reduce variability and provide its customers with consistently high quality drive-through experiences. The main theme of the video is that McDonald's must be able to quantify uncertainty by measuring variability to obtain meaningful estimates of its drive-through service time.

Video-Specific Questions

- 1. McDonald's makes the claim that it takes 90 seconds or less from the time a car stops at the order point to delivery of an order through the window. How can McDonald's substantiate this claim when drive-through times vary?**

Even though drive-through service times at McDonald's vary, they can back their claim by collecting data. Data allows McDonald's to be relatively confident that the drive-through service time is, on average, within a certain range. The appropriate statistical inference procedure for this scenario is to construct confidence intervals for the average drive-through service time.

- 2. How does McDonald's quantify the uncertainty surrounding its estimate of drive-through service time?**

When constructing a confidence interval for a mean, the uncertainty surrounding the estimate depends on the level of confidence desired, the variability in drive-through service times, and sample size. The more data collected, that is the larger the sample size, the better the estimates. Also, better estimates can be obtained by reducing the variability in drive-through service times, say through quality improvement efforts.

- 3. How can the variability in drive-through service times be quantified? Why is it important to understand variability?**

Measures of variability that can be used for drive-through service times are the range, variance and standard deviation. The standard deviation is used in constructing a confidence interval for the mean. It is important to measure (and monitor) the variability because even if the mean service time is on target, a large amount of variability means that too many customers will have a poor drive-through experience. In addition, by

understanding the sources of variability (inadequate staffing, inefficient layout, inappropriate equipment) efforts can be made to improve the process and reduce variability. Data collection after making improvements can determine whether improvement efforts were successful.

4. Why is it important for McDonald's to effectively communicate its statistical findings? What types of decisions depend on these data?

It is important to communicate statistical findings in everyday language for management to make decisions about staffing (e.g., using a wireless order taker), layout design (e.g., side-by-side drive-through), and capital investments.

Relevant Chapters in *Business Statistics* by Sharpe, De Veaux, and Velleman
Chapter 12 (Confidence Intervals and Hypothesis Tests for Means)
Chapter 10 (Confidence Intervals for Proportions)

Concept-Centered Teaching Points

Sample data are used to estimate population parameters (Chapter 10).

While the example in the video deals with estimating the mean drive-through service time at McDonald's, you can ask students to give examples of other parameters that may be estimated (e.g., the proportion). Ask them for specific examples. You can take one of these examples and give them a value for a "point" estimate and ask how they might evaluate the "accuracy" of such an estimate. This can lead to discussing the advantages of developing an interval estimate (confidence interval) rather than just using a point estimate for a population parameter.

The concept of margin of error (Chapter 10 or 12).

Extend the discussion by focusing on the margin of error. Most students will be familiar with poll results that report the margin of error in terms of percentage points (e.g., see <http://www.usatoday.com/news/washington/2009-07-13-poll-health-care>). Discuss what affects the margin of error (e.g., sample size, confidence level) and the tradeoff between certainty and precision. This is also a good time to ask students why it is not possible to be 100% confident that an interval estimate contains the true population parameter.

Confidence intervals should be interpreted correctly (Chapter 12).

Students often have difficulty with the concept of sampling distributions and the correct interpretation of confidence intervals. Consider using the example about McDonald's estimating its mean drive-through service time to provide context and develop a 95% confidence interval. Give students a variety of interpretations that are incorrect (e.g., the mean drive-through service time at McDonald's is 90 seconds 95% of the time). Discuss why it is easy to misinterpret a confidence interval and provide the correct interpretation.

Useful Links

<http://www.gallup.com/Home.aspx>

http://www.usatoday.com/news/washington/2009-07-13-poll-health-care_N.htm

BUSINESS INSIGHT VIDEOS

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Business Insight Video 7: Statistics Turns Data into Information

Summary

This video illustrates the types of data collected by *Southwest Airlines* to understand its own operations as well as to report to the U.S. Department of Transportation's Bureau of Transportation Statistics (BTS). Southwest Airlines and the BTS use statistics to turn these data into meaningful information that can be used to track airline performance and help passengers make informed decisions. Along with collecting these data within a contextual perspective (Who, What, Why, When, Where), common descriptive statistics such as percentage tables and pie charts are used to organize and present data in a meaningful way. The main theme of the video is that statistics are needed to turn raw data into useful information.

Video-Specific Questions

- 1. What types of data are collected by Southwest Airlines and reported to the U.S. Department of Transportation's Bureau of Transportation Statistics (BTS)?**

Examples of the types of data collected by Southwest Airlines and reported to the BTS include on-time arrival data (tracking when aircraft depart the gate, when they arrive at the gate, when they land, when they take off), customer complaints, and how many bags are lost. These data can be qualitative or quantitative. For instance, on-time arrivals can be categorical (on time or not on time) or quantitative (number of minutes early or late relative to the scheduled arrival time).

- 2. Describe the data collected, maintained, and published by the Department of Transportation about airlines from a contextual perspective (*Who, What, Why, When, Where*).**

Who: which flights

What: flight delays, consumer complaints, mishandled baggage

Why: extreme weather, security delays, other internal process problems

When: the date each occurred

Where: which airport was involved

- 3. How does the BTS turn raw data into meaningful information?**

The BTS uses common descriptive statistics to turn raw data into meaningful information. The specific descriptive statistics used in the video are pie charts (showing the percentage of delays attributed to various causes for a given month across all airlines) and relative frequency (percentage) tables (showing the percentage of air carrier delays

due to circumstances within the airline's control, such as maintenance problems, for each airline).

4. Why is the information obtained from data collected about the airline industry valuable? What decisions are based on this information?

This information is valuable for several reasons. It can be used to track airline industry performance over time, it can be used for individual airlines to benchmark their own performance and find opportunities for improvement, it can be used to rank airlines, and it can help passengers make informed decisions about which airline to fly.

Relevant Chapters in *Business Statistics* by Sharpe, De Veaux, and Velleman
Chapter 2 (Data)
Chapter 4 (Displaying and Describing Categorical Data)
Chapter 6 (Displaying and Describing Quantitative Data)

Concept-Centered Teaching Points

There are two basic types of variables (categorical and quantitative) (Chapter 2).

Ask students to give examples of categorical variables. You can discuss how categorical variables can be either nominal or ordinal scaled. Ask students to give examples of quantitative variables. Here you can make the distinction between discrete and continuous variables as well as discuss how quantitative data can be either interval or ratio scaled.

Common descriptive statistics appropriate for categorical data (Chapter 4).

The key idea is that we cannot get meaningful information from raw data. Oftentimes students overlook the fact that tables and charts are also descriptive statistics. You can focus on the common tables and charts used to display categorical data (e.g., pie charts, bar charts, frequency tables). Staying with the theme of the video, you can visit the BTS website and find examples of these types of descriptive statistics (e.g., see http://www.bts.gov/publications/highlights_of_the_2001_national_household_travel_survey/html/figure_02.html).

Common descriptive statistics appropriate for quantitative data (Chapter 6).

Again, emphasize that quantitative data in their raw form are not very informative. You can choose to focus on any of the descriptive statistics appropriate for quantitative variables. If you are showing all of the videos in the series, note that histograms and boxplots were featured in Video 5; consequently you may want to focus on other methods for displaying quantitative data such as tables or time series plots (if time is of importance). Staying with the theme of the video, you can visit the BTS website and find quantitative data to use in illustrating these tables and plots (e.g., see

http://www.bts.gov/programs/economics_and_finance/air_travel_price_index/html/table_09.html).

Useful Links

<http://www.bts.gov>

BUSINESS INSIGHT VIDEOS

A Guide for Use with *Business Statistics* by Sharpe, De Veaux, and Velleman

Business Insight Video 8:

One Outlier Can Change the Results of a Statistical Analysis

Summary

This video illustrates how *Starwood Hotels and Resorts* identifies outliers and researches why they happened in its historical demand data to better forecast demand for its rooms in the future. Overlooking outliers can lead to incorrect forecasts that result in negative consequences such as improper staffing or loss of investor confidence. The importance of detecting and understanding the reasons for outliers is stressed. The main theme of the video is that an outlier can greatly affect the results of statistical analysis and that, like at Starwood Hotels and Resorts, every effort should be made to identify and investigate outliers.

Video-Specific Questions

- 1. How do managers at Starwood Hotels forecast demand for rooms? What goes into generating a good forecast?**

In addition to considering future bookings from special events and current economic conditions, managers at Starwood Hotels forecast demand by looking for patterns in historical occupancy demand data.

- 2. What is an outlier? When outliers are found in the historical room occupancy data, how does Starwood Hotels deal with them?**

Outliers are unusual observations. In the historical room occupancy data for Starwood Hotels, outliers are unusual one-time events that triggered a spike or drop in occupancy. For example, a sporting event like the Super Bowl would trigger a spike; an extreme weather event preventing guests from reaching their destinations would trigger a drop. When found, outliers are examined further to determine the cause and whether it is likely to happen again.

- 3. What statistical methods are particularly sensitive to outliers?**

Many statistical measures and methods are sensitive to outliers. Methods relevant in this scenario for which the results may be affected greatly by outliers include trend analysis, regression analysis and correlation.

- 4. How can outliers be detected?**

Graphical methods such as scatterplots and time series plots can be used to detect outliers. Also, converting data values to z-scores will identify those values that are more than three standard deviations away from the mean.

Relevant Chapters in *Business Statistics* by Sharpe, De Veaux, and Velleman
Chapter 7 (Scatterplots, Association, and Correlation)
Chapter 8 (Linear Regression)

Concept-Centered Teaching Points

Use a scatterplot to detect outliers (Chapter 7).

Correlation and linear regression are particularly affected by outliers. It is a good opportunity to emphasize the importance of constructing the scatterplot as a first step not only to check the linearity condition but as a means for detecting any outliers before using these types of statistical analyses.

An outlier can distort a correlation (Chapter 7).

Discuss the ways in which an outlier can distort a correlation (e.g., Bozo the Clown effect: adding Bozo to the data inflates the correlation between shoe size and IQ). You can ask students to provide other examples.

Use residual plots to detect outliers in regression (Chapter 8).

Regression analysis results are also affected by extraordinary points. Here you can discuss how points in regression can be unusual in two ways: as outliers or influential points. This is also a good opportunity to introduce residual plots and how they can be used to detect outliers when regression is used for cross-sectional or time series data (like the historical demand data at Starwood Hotels and Resorts).

Useful Links

For an interesting article published in the *Journal of Statistics Education* on outliers see <http://www.amstat.org/publications/jse/v13n1/datasets.hayden.html>.

BUSINESS INSIGHT VIDEOS

A Guide for Use with *Business Statistics* by Sharpe, De Veaux, and Velleman

Business Insight Video 9: Collecting Good Data is as Important as Analyzing It

Summary

This video illustrates the importance *Deckers Outdoor Corporation* places on collecting good data. Good data are timely, accurate, and relevant. Good data are required to back up decisions both within Deckers Outdoor Corporation and along its supply chain. Data are collected to help understand the root cause of defects, to make decisions about raw materials, manufacturing processes, shipping, storage, inventory, and even where to locate stores. The main theme of the video is that the best statistical analyses cannot compensate for not having good data.

Video-Specific Questions

1. What factors affect footwear purchasing patterns?

While factors such as energy prices, consumer spending and economic conditions affect footwear purchasing patterns, companies like Deckers Outdoor Corporation realize the need to collect good data to capture their share of the market. They need to understand industry trends to design footwear that customers want to buy.

2. Give examples of the categorical data collected by Deckers Outdoor Corporation. What are the sources of its data?

Not all of the data Deckers collects is numeric. They collect data on the styles, colors, and sizes of footwear that sell. Sources for these data include feedback from their sales force, retail store accounts, and online retail sales managers. These data are useful in determining what designs to produce, in what quantities, and where to distribute them.

3. What types of “good” data are required in managing Deckers’ supply chain?

To manage the supply chain, good data need to be collected on customer defects to get to the root cause of the problem. In this way the process can be changed to prevent rather than correct defects. Also, good data need to be collected to understand distribution center performance.

4. Give examples of how missing data can affect Deckers Outdoor Corporation.

Inventory in Deckers’ online stores is based on demand forecasts. The online retail manager checks online sales daily, paying attention to how actual sales compare to forecasted sales. If actual sales are much higher than forecasted, she can intervene to secure more inventory so that sales demand can be met. If data are missing in the system, she is unable to intervene and may run short, resulting in dissatisfied customers.

Relevant Chapters in *Business Statistics* by Sharpe, De Veaux, and Velleman
Chapter 3 (Surveys and Sampling)
Chapter 2 (Data)

Concept-Centered Teaching Points

A sample should be representative of the population (Chapter 3).

This is a good opportunity to discuss concepts such as defining the population, how to select a sample that is representative of the population, the importance of randomization, and sample size issues. Ask students to relate these concepts back to Deckers Outdoor Corporation. For example, consider Deckers collecting data on preferences for shoe styles. What is the population? What is (are) the variables of interest? What methods could be used to select a representative sample? What issues are relevant in determining sample size? What are the problems with using a convenience sample (say, at a retail store location) or a voluntary response sample (e.g., broadcasting a survey in their online store)?

Careful wording of questions is key in collecting good survey data (Chapter 3).

Begin the discussion by noting that even if a sample is representative of the population, there are other sources of bias that must be considered. The importance of carefully wording questions on a survey so that they are understood as intended should be stressed. Ask students for examples of poorly worded questions or even questions that are intentionally misleading. You can also discuss how pilot pre-testing of a questionnaire can be done to elicit respondent feedback to help ensure a valid survey.

It is important to provide a contextual perspective for data (Chapter 2).

The main point here is that when data are collected a sufficient amount of information should be recorded to provide context. Data without context are useless. Again, using Deckers as an example, consider the data it collects on the styles, colors, and sizes of footwear it sells through various outlets (retail stores, online, etc.). Ask students to provide the *Who*, *What*, *When*, *Where*, and *Why* for this type of scenario.

Useful Links

<http://www.aapor.org>

(AAPOR = American Association for Public Opinion Research)

BUSINESS INSIGHT VIDEOS

A Guide for Use with *Business Statistics* by Sharpe, De Veaux, and Velleman

Business Insight Video 10: Checking the Assumptions and Conditions of a Model is Crucial

Summary

This video illustrates the steps involved in developing new products at *McDonald's*. From gathering data to track quick service restaurant trends and identify gaps in McDonald's menu offerings to carefully designed consumer taste tests of newly developed products, statistics plays a vital role in both the development process and successful launch of new products. Checking that the assumptions and conditions of the models used for analyzing the data is critical to making correct decisions about new creations and different product attributes. The main theme of the video is that successful new product launches at McDonald's, necessary for staying competitive in the quick service restaurant business, rely on the appropriate use of statistical models for analyzing customer data.

Video-Specific Questions

1. What is the first step in the process of developing new products at McDonald's?

The first step in McDonald's new product development process involves gathering data to track customer trends across the country, determine gaps that exist relative to these trends in the McDonald's menu, and determine what is on McDonald's competitors' menus that works for them.

2. What type of statistical methodology would be appropriate to analyze consumer panel taste tests?

Various types of experimental designs could be used depending on the number of different factors being considered and whether blocking is used. For instance, a randomized block design could be used in which each consumer tastes and rates all of the different new products. Similarly, a paired t -test could be used in the scenario described in which McDonald's is trying to decide if a product tastes better if made on one piece of equipment versus another (each consumer tastes both products made on each piece of equipment).

3. What sorts of conditions and assumptions might need to be checked?

The conditions and assumptions required for ANOVA would have to be checked. If blocking is used, the order in which consumers taste the products should be randomized. The ratings data should have similar variances for the different products. The ratings should also be normally distributed to allow statistical inference.

4. What types of data does McDonald's collect in the final steps before a new product is launched nationally?

Based on their carefully designed experiments, McDonald's continuously changes the product until the desired taste test ratings are achieved. If the new product does well in a few of their restaurants, then McDonald's begins an advertised sales test. They promote the new product in a few markets across the country and, based on the data collected, determine whether it is ready to be launched nationally.

Relevant Chapters in *Business Statistics* by Sharpe, De Veaux, and Velleman

Chapter 14 (Paired Samples and Blocks)

Chapter 22 (Design and Analysis of Experiments and Observational Studies)

Concept-Centered Teaching Points

There are benefits in using a paired (or blocked) design (Chapter 14).

This is a good opportunity to discuss one of the principles of experimental design (pairing or blocking). Because McDonald's is featured in the video, you can ask students to think about the best way to design a taste test. Should the same panelists taste all of the newly developed menu items? What are the benefits of doing so? How might not using the same panelists to taste all the menu items affect the results? Ask students to think of other scenarios (e.g., to evaluate weight loss programs) in which pairing (or blocking) is preferable to using independent groups.

Adhere to the basic principles of experimental design (Chapter 22).

In addition to blocking, you can discuss the other principles of experimental design: control, randomization, and replication. Ask students to think about how these principles apply to McDonald's taste testing. Ask students to suggest other scenarios where these principles apply (e.g., testing the efficacy of a new medical treatment). This is a good opportunity to stress the difference between experimental and observational studies.

Checking assumptions and conditions is critical for drawing valid conclusions from data (Chapter 22).

The key concept here is that model assumptions and conditions must be met to draw valid conclusions from data obtained in experimental studies. Stress that to analyze data using ANOVA methods, it is important to check that the following assumptions are satisfied: independence (achieved by randomization), equal variance, and normal population. Ask students how these assumptions can be checked. Boxplots can be used to check that variances are similar across groups and normality can be checked using histograms or normal probability plots.

Useful Links

<http://www.asq.org/learn-about-quality/data-collection-analysis-tools/overview/design-of-experiments.html>