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Abstract

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Introduction

For my research, I have been paired with Professor Howard Kunreuther, a Decision Processes professor in the Operations Information Management. Professor Kunreuther specializes in analyzing low probability, high consequence events. This broad focus was given as the direction for my research.

Power failures, according to the Disaster Recovery Journal[1], are the second most common cause for business interruption, the first of which is human error. On August 14th, the largest blackout in North American history crippled most of the east coast and Midwest and resulted in initial estimates of losses totaling $6 billion[2]. This event, and the heavy media coverage that followed, sparked my interest in how firms protect against these losses. History makes this topic particularly interesting. For many firms, this was the first real test of post-Y2K and September 11th disaster recovery systems.

Most power outage literature works to assess both the social and financial cost of power outages, using proxies, surveys and market data. Proxies, such as back-up generator prices (Bental and Ravid 1982[3]), help reveal estimated outage cost. However, proxies can only measure lower or upper bounds on outage costs for average conditions. Surveys, sponsored by countries (such as Canada[4]) or conducted by researchers/consultants, use hypothetical situations to obtain estimates of outage cost or the willingness-to-pay (WTP) to avoid hypothetical interruption. "Hypothetical bias" combined with the infrequent nature of power losses creates serious problems relating to the validity of such survey results. Market data, the third and least biased approach, is viewed as a superior method of calculating outage cost, although a general lack of suitable data exist. Some studies which have tried this method are

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[1] Disaster Recovery Journal online survey. (www.drj.com) January 2003

[2] Hilsenrath, Jon. The 2003 Blackout: Economy Won't likely be Derailed --- Cost could hit $6 Billion as major sectors are hurt; A few reaped Benefits. The Wall Street Journal. Dow Jones & Company, Inc. 18 August 2003.

[3] Bental, B., and S. A. Ravid. 1982 "A Simple Method for Evaluating the Marginal Cost of Unsupplied Electricity." The Bell Journal of Economics 13 (1): 249-53.

[4] Billington, R., G. Wacker and E. Wojczynski "Customer Damage Resulting form Electric Service Interruptions, Volume I. Prepared for the Canadian Electrical Association, R&D Project 907 U 131, April 1982.

Beenstock and Goldin 1997[5] that use the purchases of back-up generators in Israel to infer firm's assessment of outage cost as well as Caves, Herriges and Windle[6] that use participation in Interruptible Service Programs, where companies obtain a discount for agreeing to reduce electricity demand to a agreed upon level. These studies demonstrate the difficulty in assessing the cost of an outage, or in other words the benefits of protection.

This research, however, looks to see how firms evaluate each of these and other investment opportunities. What are the options that corporations consider and utilize to prevent power loss? How does a company make investment decisions that prevent or mitigate losses resulting from power outages? How does the firm evaluate each investment in the context of a high degree of event uncertainty? To answer these questions, this research looks both at already existing theoretical foundations and then uses a case study to highlight the resemblances and deviations that exist in a firm's decision processes.

I will begin by introducing some options that firms consider. This section provides you with the fundamental lingo to address what viable options are available to firms – highlighting both the wide variety and the interconnectivity inherent in these options. Next, I will discuss some existing literature surrounding how firms make investment decisions, focusing specifically on the two approaches, normative and behavioral, that I will employ. Followed by this literature overview, I will provide background for the case study, bringing you up to speed on what protective structures already exist and how the organization is designed to evaluate protective investments. Then I will actually present the normative model within the context of protection against power outage losses. I will return to the firm's processes by first concentrating on pre-selection financial analysis and prioritization. This will lead to

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[5] Beenstock, Michael and Goldin, Ephrain. The cost of power outages in the business and public sectors in Israel: Revealed preferences versus Subjective Valuation. Energy Journal. 1997. Vol 18 Issue 2, p39.

[6] Caves, D.W., Herriges, J.A. and Windle, R.J. "The Cost of Electric Power Interruptions in the industrial Sector: Estimates Derived from Interruptible Service Programs". Land Economics. Feb. 1992. 68(1): 49-61.

the introduction of an adjusted model and then to the first two phases of the behavioral model. I will return to how the firm selects the investments and financially submits them for budgeting and approval. The conclusion of the firm's processes will allow us to complete the behavioral model, again systematically analyzing the firm's actually decision-process. To fully synthesize the behavioral model throughout the paper, I will provide an example of projects that have either been considered or implemented by the firm. I will take these examples through the three-phase process to see how the firm's investment behavior matches the model. Finally, I will provide policy recommendations, focusing specifically on why and how these suggestions should be presented to the firm.

Key Options that Protect Against Power Outages:

Again, to get a better idea of the technology available to protect firms against power outage losses, we will begin by looking into some of the more popular investments that firms consider.

Backup Generator: The backup generator is the foundation of power loss protection. There are a variety of generators available, but the important differentiating factors are power output and fuel. Power output is the "size" of power produced, rated in watts or kilowatts, and range from a small 800-watt unit to a building unit of 1500 kilowatts or more. Fuel options include gasoline, diesel, propane or national gas and may be started automatically with a battery or a manually with a pull-cord. The generator is not running constantly, therefore in the event of an outage, there is an initial time frame for which power is still lost.[7] Due to the size and cost of these systems, firms often do not backup all systems and instead support only critical systems with the full backup generator power. To provide and

[7] Kirkwood, Byron. "Power Outages and Emergency Backup Generators: Survival Guide for the New Millennium." B&A Products. Bunch, OK. August/September 2000. http://www.baproducts.com/generato.htm.

example and also get an idea of system cost, the firm used in for the case study section invested in a $800,000 for a generator that protects only part of their main complex.

Uninterruptible Power Supply (UPS): The short power loss inherent in the power-up of the generator creates a need for an additional device, the UPS. A UPS in a constantly running backup mechanism that purports three main functions: protection against small outages, provides time needed to power-up and transfers to backup generator power for critical systems and allow for a graceful shutdown of all remaining devices. UPS systems are often attached to software programs, which in the event of an outage, request the user to properly save any information before shutting down the computer or system. The two key features of a UPS system is the power output, usually in volts, as well as the estimated time allowance as a function of power output and protecting systems. Usually, UPS systems are structured to be able to operate for a few minutes.[8] To provide and example and also get an idea of system cost, the case study firm purchased a APC PowerStruxure UPS systems to provide 80 KW of power for the first floor computer room and 80 KW of power for the second floor computer room for $250,000. Based on the usage requirements for that area, the UPS system will operate for 21 minutes.

Back-Up Systems/Off-site locations: Back-up systems and off-site locations are probably the most elaborate option available to firms. These systems provide either an exact replica or comparable space for which information is either automatically saved or can be transferred to. In other words, these options provide alternative locations in the event of a power outage. The scale of these investments varies significantly. Some firms have invested in 'hot sites', which are exact replicas of all/most/some of the firms systems. These locations are continuously updated and are meant to provide an

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[8] Christenson, Nick. "FAQ document on Uninterruptible Power Supplies," Version 2.1a. May 6, 2001. http://www.jetcafe.org/~npc/doc/ups-faq.html#02.

environment for which employees could pick-up where they left off with the same information available to them. On the other hand, some back-up systems merely periodically copy parts of a firm's information. Some firms even take advantage of their "hub and spoke" system, where nearby divisional locations house similar facilities. To provide and example and also get an idea of system cost, the case study firm is budget to invest in the absolutely smallest back-up system at a cost of $60,000. The range of cost they provided was $60,000 - $100,000 for a small system up to an extensive multi-million dollar option.

Priority Rental Agreements: Priority rental agreements usually constitute paying for an exercisable option to use some of the above equipment if an event occurs, and is most common with generators. Firms, such as Aggreko (http://www.aggreko.com/), work with clients before an event to obtain all the necessarily protection requirements, pre-selecting equipment, levels and conduct any necessary pre-wiring. Firms can then tell these rental agreement providers that they would like to bring the pre-agreed upon system on site and within 24 hours the system must be provided. Then they firms have another option if in fact they use the systems. As expected, firms pay a yearly premium to maintain this rental agreement, around $50,000.[9] There are also additional charges if the protective measures are brought on site and more charges if the system is actually used. While there undoubtedly is a premium attached to many aspects of this process, these types of agreements allows firms to forgo capital expenses, obtain newer up-to-date technology customized specifically for their pre-specified need. In essence, these agreements expand the options firm have to deal with both anticipated and unanticipated events.

Disaster Recovery Plans: Disaster Recovery Plans are an overarching protective measure, used in the event of a power failure as well as a multitude of other events. The goal of these plans is to enable to

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[9] AA(initials): Vice President of Strategic Planning. Personal. March 11th, 2004.

organization to survive an event, minimize the losses and return the firm back to normal operating levels. Most importantly the plan must identify and be tailored to the individual firm's needs and risk exposure. Plans can include anything from evacuation procedures to emergency contact information for both within the firm and as well with important suppliers and customers. While the above may sound simple, a good disaster recovery plan requires a large amount of discussion, development, revision and testing.

Testing: Testing is the final protective measure that I will briefly analyze. Though it is difficult to simulate a crisis, realistic testing is an integral part to determining the effectiveness of a disaster recovery plan and existing protective technologies. Test can include walkthroughs, simulations or surprise testing. No matter the method, reporting and follow-up procedures allow the firm to learn and adapt their infrastructure or disaster recovery plan accordingly.

Existing Investment Literature

After looking at the options available to firms, we can begin to analyze the processes that firms use to select investments. First, however, we must develop a framework, or model, for evaluating the firm's decision processes. There has been extensive literature devoted to capital budgeting. The relevant literature is divided into two sections: normative and behavioral.

The purpose of the normative model is evident from its' name. It provides a norm, or a null hypothesis, for which we expect firms to evaluate investments. In the context of capital budgeting, Bierman and Smidt offers a summary of the normative approach we will employ.[10] The capital budgeting process requires that the firm select a discount rate, which reflects the time value of money,

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[10] Bierman, Harold, Jr. , and S. Smidt, *The Capital Budgeting Decision*, 2d Edition, New York: The Macmillan Company, 1966, p. 1 in Joseph Bower's *Managing the Resource Allocation Process*.

and apply that rate to discount the future cash flows. Based on this present value number, the highest present value should be selected. In effect, the normative approach to decision making is based on the foundation of net present value. A basic net present value calculation is thus:

$$\text{NPV} = -C_i + \sum_{t=1}^{T} CF \Big/ (1+r)^t$$

The cash flows, *CF*, generated from the investment are discounted for the life of the investment, *T* years, by the cost of capital, *r*, resulting in the present value of the investment. In order to obtain the net present value, we must subtract the initial cost, C_i, of the project. In the case of capital or budget constraints, net present value not only shows us which investments provide attractive returns but also allows us to rank those projects. So that in the presents of a capital constraint, *C**, we should invest first in Investment 1 then in Investment 2 until we reach *C** where as:

$$\text{NPV}_1 > \text{NPV}_2 > \text{NPV}_{3\ldots\ldots}$$

However, economists have come to find that people in the world often do not act in a normative way. As a result, the field of behavioral economics, which focuses on what firms actually do instead of what they theoretically should do, has developed significantly in the last fifty years. There are three specific aspect of behavioral literature that are particularly important: bounded rationality, probability assessment and event-driven investments in the context of the availability bias.

Bounded rationality, a concept developed in the 1950's by Herbert Simon focuses on the fact that agents, in this case firms, face uncertainty about the future and costs in acquiring information. Both of these factors limit the extent for which agents can make fully rational decision. This limited information processing capacity drives individuals to make decisions based on "rules of thumb".[11] For this research, I will represent those rules of thumb using a sequential model. This type of behavioral modeling outlines a step-by-step process that firms use when analyzing investments.

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[11] New School University. Website on History of Economics and Thought. http://cepa.newschool.edu/het/profiles/simon.htm.

As we will see with the normative model, an integral factor influencing the firm's decision making is the expected value of benefit a firm would receive from a protective measure. In order to obtain that information, one would correspondingly need the probability that an event will occur. Particularly for low probability events, such as power outages, calculating this probability can be quite difficult. As a result, there is recent academic evidence, particularly in Sustein[12] and Schade etc.[13], that "concern with experiencing a loss rather than probability of the loss occurring" explains insurance purchases in relation to low probability, high-risk events. This probability neglect is exceptionally strong when the likelihood of an event is ambiguous. Although insurance is not often a mechanism used to protect against power outage losses, I would hypothesize that similar heuristics would be used when evaluating other investments targeted at low probability-high risk events. When firms do use probabilities, it is important that their assumptions are clearly understood and result in meaningful approximations. As we will discuss more in detail later, recent literature has began to explore various diagrams, Exceedence Probability Curves (**Figure I**), that illustrate the underlying assumptions and resulting distribution of probabilities for a given event.[14]

Finally, we need to explore the prevalence of event-driven protective measures. One of the foundation that explain event driven reactions is due the availability heuristic developed by Kahneman and Tversky.[15] This heuristic has shown that individuals often estimate the probability of an outcome based on how easy it is to imagine or recall that outcome. As a result, vivid, emotionally charged possibilities will be perceived as being more likely that those that are harder to picture or difficult to understand. Recent outcomes will also be perceived as more likely in the future. Various case studies,

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[12] Sunstein, Cass R. "Probability Neglect: Emotions, Worst Cases, and Law," Yale Law Journal 112, 2002, 61-107.
Sunstein, Cass R. "Terrorism and Probability Neglect," Journal of Risk and Uncertainty 26, 2003, 121-136.

[13] Schade, Christian, Howard Kunreuther and Klaus Peter Kaas. "Probability Neglect and Concern in Insurance Decisions with High Stakes. For *Journal of Risk and Uncertainty*. Working Paper. March 31st, 2004.

[14] Kunreuther, Howard. "Risk Analysis and Risk Management in an Uncertain World." Risk Analysis, Vol 22, No. 4, 2002 pg 655-658.

[15] Tversky, A. and Kahneman, D. "Judgment under Uncertainty: Heuristics and Biases", *Science* **185**, 1974, 1124-1131.

such as those seen in Edward Lawless's book *Technology and Social Shock*, provide further evidence to support such a conclusion.[16]

The above literature only provides a framework for understanding models utilized in this research. Many of these ideas will be revisited and expounded on later on in this paper.

Background to Case Study:

In order to probe deeper into the decision processes of firms, I will utilize a case study example throughout this research. The firm I selected is a division of a news organization. Collection of information used in the case study was derived from a preliminary survey **(Exhibit 1)** as well as two interviews, one two hour personal interview with the VP of Strategic Planning[17] and one hour phone interview with the Financial Manager[18]. The news organization has provided 128 years of continuous publishing, creating high expectations for the business continuity team.

Before looking into the firms actually investment analysis, it is important to analyze the context for which investment decisions are made. The Business Continuity Planning (BCP) team makes most of the "protective" investment decisions, including those that protect against power outage losses. This team is composed of representatives from the main 25 functional areas of the firm, with particular representation from technology and finance. Team representatives work with the BCP group in additional to performing their main duties in their respective functional group. The main purpose of the team is to solicit ideas and needs related to business continuity and review the firms Business Continuity/Disaster Recovery plan bi-annually, one primarily focused on hurricane related issues. The Business Continuity plan is an extremely large document, at least a few hundred pages, that is centered around 12 critical systems (utility, telecom, water etc.). The firm creates possible scenarios intermixing

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[16] Lawless, Edward W. *Technology and Social Shock.* Rutgers University Press. New Brunswick, New Jersey. 1977
[17] AA: Vice President of Strategic Planning. Personal Interview. March 11th, 2004.
[18] DV. Financial Manager. Telephone Interview. March 16th, 2004.

these 12 systems, providing decision makers in each functional group with response guidelines and product availability options. The firm's work-around for a "no power" scenario can be seen in **Figure II**. The numbers across the top of the diagram represent locations, 1 being the main complex, for which a power outage would occur. The firm then codes additional factors, A, B and C, which constitute various conditions such as "generator is functioning." With this information, the firm assesses which news products would be available to create; color-coding the feasible options in green and the unfeasible options in red. The plan is distributed to the Vice Presidents, Directors and heads of the functional areas throughout the organization and each party is instructed to read it cover-to-cover after every revision.

This BCP group is also responsible for "protective" idea generation. Here, the head of strategic planning assigns team members to do a firm "gap" analyses: analyzing their and other functional areas current susceptibility to business continuity risk. Their goal is to report what risk "keep them up at night". For planning purposes, the technology group also approaches functional areas and request a list of needs over the next 1-2 years. More recently, corporate headquarter has requested a 10-year plan, a task which utilizes a similar procedure but more closely utilizes financial planning. Finally, the VP of strategic planning obtains additional recommendations from other VP's, Directors, upper management as well as outside business continuity auditors. The VP of strategic planning then creates an exhaustive list of ideas, all of which are discussed by the BCP team.

The firm has worked extensively with this organizational framework. In fact ,current protective investments are "building on a foundation" that started long ago, but has only recently been expanded and fully developed. The firm initially only focused on business continuity related to hurricanes, due to geographic high risk. The firm used various protective measures, such as UPS systems, priority generator agreements and two electricity input lines from the power company, to combat possible power outage losses that would result from a storm. In preparation for Y2K, the firm used this opportunity to update critical systems and fund a "much needed" back-up generator for the main facility. The firm worked on expanding their scenarios related to business continuity planning, resulting in a more comprehensive "traditional business continuity". Finally in the wake of September 11th as well as a firm targeted Anthrax scare, the firm began to consider more significant, longer-term disruptions, which they categorize as Disaster Recovery. This further increased scenarios considered when discussing protective investments.

Now, we are up-to-date on the basic organizational processes employed by the firm and we can begin to concentrate on how they evaluate investment options. To provide an outline for the upcoming sections, we will begin by setting our normative decision making model. We will look at reality beginning with investment prioritization and pre-selection financial analysis and follow up with Phase I and II of the behavioral model that better describes these activities. We will then move back to look at what the firm does in the selection, budgeting and approval stages of the decision process, again following up with Phase III of the more representative behavioral model. To pull the behavioral model together, I will illustrate the process using an investment throughout the paper. Finally, I will address policy recommendations that stems from the actually process employed by the case study firm.

<u>Normative Decision Making Model</u>

Again, we will start out by developing a specific normative model of decision making that we hypothesize the firm should follow. Based on the information in the literature section, our based model is the net present value formula.

$$\text{NPV} = -C_i + \sum_{t=1}^{T} CF \Big/ (1+r)^t$$

In our example, however, we are considering investments that do not generate cash flows, but instead obtain expected benefits in relation to power loss events. As a result, we use a slightly more complex model to demonstrate the expected value of the investment. Here the yearly "cash flows" consist of maintenance cost, C_t, benefits obtained unrelated to the probability of a power loss, U, and the expected benefits obtained contingent on a power loss event. An example of benefits obtained irrespective of power loss likelihood could include decreased need for labor or other cost eliminations. The expected value of a benefit contingent on a power loss is equal to the probability, p_t, that the event will occur in period t multiplied by the benefit, B_t, obtained in an event.

$$\text{Normative Model: } -C_i + \sum_{t=1}^{T} \left({-C_t + U_t + p_t B_t} \Big/ {(1+r)^t} \right)$$

Those yearly "cash flows" are relevant for every period, t, as long as the investment exist, T. This time length is often based on length of depreciation schedule, years of economic life based on GAAP, generally accepted accounting principals.

Net present value is not the only way to consider an investment. The company in our case study, in fact, uses another method called Return on Investment (ROI). Return on Investment analyzes the annual rate of return for the profits or losses resulting from an investment.[19] The company sets a hurdle rate, the minimum return that is acceptable to invest in a project.

$$\text{Hurdle Rate} <= \text{Annual Percentage Return } (-C_i, CF_i \ldots. CF_T)$$

The return of investment calculation is related to net present value. We will show that relationship through an example.

Let's say there is an investment opportunity for which the initial cost is $100 and the investment will create cash flows of $20 for 10 years. The hurdle rate set by the company is 12%. Your annual rate of return for this investment is 15%. Because your hurdle rate is less than you annual rate of return, you would invest in the project. If you used this annual rate of return, 15%, as a discount rate the NPV

[19] Investopedia.com. "Return on Investment – ROI," Equade Internet Ltd. http://www.investopedia.com/terms/r/returnoninvestment.asp.

would in fact be $0. So that for any hurdle rate below your annual rate of return, your NPV will be positive and thus you would also invest in the project. In theory, all projects that meet the specified hurdle rate provide attractive investments for the company and should result in an investment. When the ROI is above the hurdle rate, one should rank the projects in descending order, from highest ROI to lowest ROI, and invest up to the capital constraint, C^*.

In the next section, we will take a detailed look at the firm's decision-making process. It is important to keep in mind both the normative model outlined above as well as the other aspect of relevant literature. After we flesh out all the case information, we will come back to the normative model, make primary adjustments and then due to "unexplainable" factors will continue on by developing a behavioral model.

Case Study: Prioritization and Initial Financial Analysis

After the list of possible investments is collected, the BCP group discusses all possible options. Most of the discussion focuses on possible implementation problems, obtaining the necessary feedback from the functional teams, who will have to deal with the ramifications of each investment. Any financial analysis conducted is commissioned based on individual requests. As a result, the type of financial information available for each investment varies. However, there seems to be some consistency in the fact that the numbers are "basic". This basic financial analysis addresses the following questions: How much profit is at stake if we can't produce a paper (average, weekday, and maximum, Sunday, losses)? What is the basic system going to cost? There is some understanding of role this specific investment plays in relation to already existing protection, but only in the context of the potential work-out scenarios that will subsequently be protective. Even this type of understanding is not exhaustively pursued.

As we will see, a full-cash flow model is more prevalent for profit generating investments or after an investment has already been selected. The next section will probe deeper into the details of such a full-cash flow analysis and analyze further the consequences of "basic" financial analysis.

Adjusted Model:

In the case where the full cash flow analysis is conducted, we must adjust for the fact that the news organization uses a risk premium in addition to their cost of capital. When we translate this to the expected value calculation used in our normative model, we can represent it as an additional discount factor, *d*.

$$\text{Adjusted Model: } -C_i + \sum_{t=1}^{T} \left(\frac{-C_t + U + p_t B_t}{(1 + r + d)^t} \right)$$

In the case study example, the cost of capital, r, is equal to 10% while the additional risk factor, d, is equal to 2%. The resulting hurdle rate, 12%, is constant and used firm wide. Under normative assumptions only the cost of capital should be used and we, therefore, must probe further into why a risk premium is added. Based on information provided by the financial manager, the risk factor allows for "some unforeseen problems such as a unanticipated expenses or a slight economic downturn that causes revenues to lower than predicted."

There are a few unresolved issues related to this justification. First, even though a constant rate is used firm wide and across time, the probability of these factors, "unforeseen problems and economic downturns", varies. As a result, both factors can be more accurately measured given the time and circumstances surrounding an individual project. For example, one could support the fact that their exist a great risk of an economic downturn given the events of September 11th and therefore an investment purchased before that date should have a different risk factor than the same purchase after September

11th. Similarly, one could argue that a replacement system has a lower risk of "unforeseen problems" than that of a new system. In addition, a risk discount rate does not seem to reflect the explanation and would be more accurately replaced with probabilities. Here the firm could separate the probability of "unforeseen problems" and the probability of an "economic downtown" and then apply those probabilities to either the cost or benefits as they deem appropriate. Actually calculating the probability of each factor from market data would allow for a more accurate approximation, instead of the general 2% that is currently added to all projects. Overall, there is no "normative" problem relating to the underlying need to take into consideration "unforeseen problems and economic downturns". However, the mechanism used does not allow for a market driven, unique approximate inherent in each individual project.

While the following variations are important to outline, this full-cash flow analysis is usually conducted with profit generating investments and only post-selection for profit maintaining investments, such as protecting against power outage losses. The financial analysis conducted before pre-investment selection is commissioned only at a team member's request. However, there seems to be some consistency with regards to the information obtained. As noted in the case study section, the team usually request a "basic" model cost figure as well as a rough understanding of the profits the investment is protecting. As we can see, this basic analysis provides no evidence to the support that the organization takes into account the probability of an event when determining benefits. The probability of a power failure is hard to determine. There are an enumerable amount of events, some with very small probabilities, that may result in a power outage; hurricanes/natural disasters, power grid failures, lightening, terrorism, even a local traffic accident. Though the exact probability of an event is difficult to determine, based on the firms initial survey result, the firm does have the ability to generally estimate probability ranges. Benefits, particularly "protected" revenue, associated with the single investment are difficult to measure given the interaction between multiple layers of protection. For example, given that the organization already has two entry power lines from the electricity company, various generators protecting some parts of the building, a unique alternative work off-site work areas due to close auxiliary locations along with a priority generator rental agreement, what exact percent of revenues is the UPS protecting? The depth of the firm's financial analysis and method of actually taking expected benefit into consideration varies depending on individual request and accessibility of information. In fact, the firm does not justify probability neglect based on the difficulty of assessment but instead states that:

> *"The kinds of things we are considering - we know this is the next step we should take. We're not really weighing 1 project versus another. Well, we are going to do one this year and one next year. Our priorities are already set. It's just trying to find out the level."*[20]

We will see this idea fleshed out in the next paragraph. There is, however, a more systematic method that the firm could employ to provide a better indication of the degree of uncertainty regarding the likelihood of occurrence and the resulting losses.

In response to September 11th and Anthrax threats, researchers have utilized one method, the Exceedance Probability Curve **(Figure I)** developed from Hurricane Andrew and the Northridge Earthquake, to break down this often-difficult factors relating to extreme events.[21] These curves specify the probability that a loss level will be exceeded. As a result, we obtain a better idea of the distribution of losses and are forced to explicitly consider and state the assumptions used to derive the probabilities necessary for the normative model. While this method may alleviate some of the problems resulting from the difficulty in assessing low probabilities, I must again point out that the firm does not use "indetermination" as a justification for not using probabilities. Instead, they state that probability

[20] AA: Vice President of Strategic Planning. Personal Interview. March 11th, 2004.
[21] Kunreuther, Howard. "Risk Analysis and Risk Management in an Uncertain World." Risk Analysis, Vol 22, No. 4, 2002 pg 655-658.

analysis is unnecessary in their prioritization and selection of investments. We will revisit this fact in our final policy recommendations.

In addition to not using probabilities, the limited analysis concluded before project selected does not allow the firm to rank the projects in descending order and invest up to the capital constraint, C^*, as expected given normative ROI analysis. It is important to note how the lack of clear financial analysis allows other "qualitative" factors to influence selection. There is evidence that the type of project, politics, individual preferences, origination of idea and perceived priority all play a role in the selection process. As we have seen, there is ample evidence to reject that the firm in fact uses a normative approach to decision making. In response, we have constructed a sequential behavioral model to breakdown the processes the firm employs. This model does not show how the company should make decisions, but in fact how it does. In the process, we will explain how the firm integrates ROI calculations, "qualitative" factors and demonstrate other methodology used in prioritizing, evaluating and deciding between investments.

Behavioral Model: Prioritization and Basic Financial Analysis

These first two phases of the behavioral model will only focus on prioritization and pre-selection financial analysis. This process creates a general model, describing the firms current process for all business continuity related investments; power outage losses is included. As discussed in the adjusted model section above, the firm does not order projects in descending order from highest to lowest ROI. Instead, we see the firm respond to investments differently, taking into consideration quantitative and qualitative factors.

After receiving a list of all the investments, the first step in this process, grouping, begins where the investments are subdivided into buckets and treated "similarly" within each group and "differently" between groups. I have analyzed this process in **Figure III**. As seen in the diagram of the grouping process, there are four groups: First Group, Second Group, Third Group and Deferred Group. To begin the grouping process, the firm first asks if the investment opportunity is reasonable. Reasonability is determined based on the interaction of cost and division profits minus fixed cost. For example, the firm considered a "hot site" for Y2K, an off-site location that would duplicate parts of the home office. The estimated project cost, however, was "out-of-sight". In effect, the firm has set a C_{max}; the maximum cost the firm is willing to pay regardless of benefit. All investments where $C_i < C_{max}$ are considered "reasonable". As a result, a giant layer of possible investments is eliminated as investment opportunities. Reasonability can also encompass implementation issues that may arise. For example, when discussing backup site locations, different functional teams discussed the initial location. An apparent problem surfaced with regard to the proposed location and a new idea had to be created. Next, the firm asks if the investment is "necessary". The definition and identification of necessary investments are inherently important in understanding the firm's process. After investments have been determined, it is easy to post-identify the necessary projects as those that received funding regardless of any budgetary constraints. These are projects that will be completed regardless of circumstances. For example, after the serious failure of the UPS, additional money was obtained and placed in the budget because replacement became necessary. Pre-identification is somewhat more difficult to fully predict, however, the case study provides indicates some factors considered including origination of idea and event related factors. For example, ideas originating from an outside business continuity audit or those required by corporate headquarters are automatically placed in the first group. Events that either mandate system upgrades, such as Y2K, or expose new vulnerabilities, such as September 11th, the anthrax attack on the firm, and the entrance of an escaping felon into the firm's facilities, are also put into this first group. As the literature section demonstrates, this event driven mindset is not uncommon.

In particular, these events increase internal awareness and result in a higher probability of overall committee agreement and increase the probability of budgetary approval.

Next, we see a segmentation of those investments that replace or expand already existing equipment. Investments found in this group are often items that are a result of expansion or are units being used beyond their economic life. Because the economic life, as determined by Generally Accepted Accounting Principals, may not reflect the life span of the item, it is not unusual for many systems to be used beyond this point. Replacements, the Second Group, are differentiated from new investments, the Third Group, because initial analysis completed by the firm already established a need for the underlying investment. Because these protective measures do not exist and have not been identified as a "necessary" investment, they are placed in the last group. As we will see, investments in this group are rarely invested in due to capital constraints.

This systematic grouping leads to a cohesive agreement within the group with regards to what project groups obtain priority. After, or during, grouping, basic financial analysis can be collected. Specific types of projects are more or less likely shown to have financial information requested. This basic financial analysis, Phase II, is visually represented in **Figure IV**. Replacement or expansive items either result in little or no financial analysis, due in most part to the fact "need" has already been established and therefore detailed financials. Detailed financials are obtained after the prioritization process in the later stages of selection and budgeting. Basic cost and profit protection information is obtained for new, event-driven protective measures, answering the questions posed in the financial analysis section of the case study. And finally, new, non-event driven investments are more likely to be explored in detail, especially with regards to cost and implementation feasibility.

Now that we have developed an understanding of prioritization and the financial analysis that occurs before pre-selection, I will provide an example within the firm to illustrate this part of the model.

I will focus on the firm's most recent power outage investment, the replacement of a UPS. A large part of the initial survey, **Exhibit 1**, focused on this investment. After the investment reached the list of options, it was initially classified in the deferred group, due to the fact that the equipment was functioning properly. During this time, other investments such as those related to Y2K as well as a back-up generator after September 11th received funding. Eventually, the UPS system, not past the economic life, began to have "insignificant" malfunctions that did not result in any large losses to classify the replacement as a necessity. The investment, therefore, was placed in the second group. Due to other investments relating to September 11th as well as budget constraints given the poor economic conditions, the replacement was not conducted. Finally, a "significant" instance occurred where the UPS did not function properly during an outage. The firm was still able to produce a full paper, however, the time loss was enough to extremely inconvenience employees. As a result, the replacement UPS became a necessity and was placed in the first group. During this time, the only financial information commissioned was a range of cost for a replacement system. The range of cost is not available from the firm, due to the fact that an actual cost figure replaced the range once the exact system was selected and installed. We will move on to the case study selection to further analyze what occurs after prioritization, selection and then budgeting and approval.

Case Study: Selection, Budgeting and Approval

Once we have an idea of the prioritization, investment selection is based on two additional factors: the budget constraint and the level of investment. The Business Continuity Division is not given a specific budget before the start of the decision process I have described here. However, the division is working in a limited capital environment for which business continuity investments, particularly those that protect against power outages, are fighting for capital. Given that the budget is "developed", we will begin by looking at the first group investments. One of the ways of post-identifying a first group, "necessary" investment is that regardless of firm financial circumstances funds were secured. As a result, we see that all investments in the first group are automatically selected. The relevant technology is selected at the optimum level. Detailed cost information is obtained and for some investments a full cash flow model is constructed. Once all the cost of the necessary protects are obtained, the Chief Financial Officer (CFO), Technology Director and Publisher determine a budget constraint. Factors that influence their decision include existing fixed cost, firm performance, economic conditions, returns of other "profit generating" investments, investments in the second and third group and origination of idea. One of the factors that I would briefly like to focus on is the relationship between existing second and third group options and the budget constraint. This relationship exists primarily because of the minimum cost related to certain investments. The Technology Director and CFO can then determine how much additional capital would be needed to adequately, not optimally, invest in an additional protective measure. As a result, we see the selection of all of the first group, some of the second group, depending on each options capital needs as a function of the opportunity cost and capital available, and an even fewer amount of the third group.

Much as the first group obtained more detail financial information, the remaining selected investments go through a detailed budgeting process. Often this processes intensely focuses on selecting the optimal, or if due to financial constraints adequate, protective measure and meticulously outlines the cost of the investment. Little detail was provided with regards to the approval process other than the verification that given the wide variety of input throughout the process, there are few surprises. Budgeting and approval, in fact, is the last stage of the investment decision process.

Again, we have already seen in the prioritization stage that the firm does not follow the normative model. In the next section, we will continue the sequential behavioral model.

Behavioral Model: Selection and Budgeting

Given the process as outlined above, we can outline a systematic process the firm uses in the selection process **(Figure V)**. We begin this process knowing the complete list of investments, the relative group for which the investment resides (First, Second, Third) and any pre-selection financial data. The financial data of particular importance is the minimum cost of the investment. In the model we label the cost of the first group, C_1, the second group, C_2 and the third group, C_3. We automatically invest in the entire first group and thus have an accurate estimate of C_1. Next, a budget constraint is determined based on the processes discussed in the case study above. Then given the fixed cost and the cost of the first group of investments, the firm would invest in second group projects until or at levels so that the total cost is less than or equal to the budget constraint. The same process is repeated for the third group of investments.

Again, I will return to the UPS example used in the behavioral model section related to prioritization and pre-selection financial analyses. Before the investment was placed in the first group, it resided in the second group, whose selection is highly dependent on the budget constraints. Again, due to other investments related to September 11th as well as the poor economic conditions, the investment was not selected. Once the investment was placed in the first group, it obtained funding regardless of the cost. Technology worked with finance to select the exact model and detailed cost information was obtained (see **Exhibit 1**). The benefits constructed by the firm include a general amount related to a total loss of printing for the day. Given that the UPS provides only a small fraction of that protection, most of the benefits listed by the firm were of a qualitative nature including increased reliability, the addition of an automatic transfer switch linked to the back-up generator, increased monitoring capabilities, the option to expand the system and finally ease of maintenance. Risk related to the project were also qualitatively evaluated including the conversion downtime related to the replacement, increased space required in computer rooms, the existence of "better" available systems and unclear maintenance support at the time of budget/approval submissions. The investment was approved and was installed in July 2002.

<u>Policy Recommendations</u>

I have firmly established that the firm does not utilize a normative model of decision-making. However, as I discussed in the existing literature section, other firms or agents have observed many of the deviations the firm exhibits. Though prevalence does not conclude "correctness", there is something to be said about recurring deviations from the norm.

Given these factors, I would like to purport some policy recommendations based on the firms behavioral model. First, during full-cash flow analysis, the firm did not provide ample justification for the additional risk factor used above the cost of capital. If the risk adjustment is due to "economic downturns and unanticipated expenses," the firm should use a project, time specific estimation for that risk factor. With little additional "investment" in research, the firm will be able to better reflect the risk and reward of the project. In particular, the adjustments should increase budgeting accuracy. Ample incentives already exist within the firm given that many employees, including the VP of Strategic Planning, are compensated based on adherence to budgeted financial plans as well as performance related to the revision of the BCP plan. Given these incentives combined with the fact that the 2% risk factor is a constant, firm-wide figure dictated by corporate headquarters, I would hypothesize that little adjustment resistance would exist on the divisional level, but instead may be concentrated at a corporate level.

Secondly, I believe it is important for the firm to understand the probabilities of an event occurrence. One of the questions on the initial survey, **Exhibit 1**, probed into the firm's probability beliefs. The firm's initial response was to state that they "did not think this way," but after requesting that they "give it their best shot" ranges were obtained. We see, therefore, that the firm has the capacity to think probabilistically about these events. However, we have not established if in fact those estimates are meaningful, a requirement to create value. As I briefly discussed in the literature section as well as the adjusted model section, graphical representations such as the Exceedence Probability, EP, Curve may help the firm better understand these assessments.[22] The EP curve, **Figure 1**, plots the loss in dollars versus the probability that the loss will exceed a given level. The EP curve captures two effects, the uncertainty in probability as well as the uncertainty in loss. Those levels of uncertainty effect the confidence interviews observed in the EP diagram.

Given EP curves may be an excellent method of understanding probability estimates, we must return to establish in what circumstances they are most useful. For example, if a firm is unwilling to give up the "control" and possible financial and political leverage the definition of "necessary" provides (see first group in Phase I of behavioral model), probabilities may be unnecessary to analyze for first group projects and may be more appropriate for replacement equipment or new, non-event driven investments. A new back-up data system, which resides in the third group, is a perfect instance for which the firm could use such methods. This project, which is now budgeted for 2005, has continuously been deferred due to capital constraints. Many BCP team members were hesitant about the investment due to the fact that it was "unnecessary" in the past. If the group had evidence to support that given the probability of an event the investment would an optimal choice, skeptics would be presented with concrete quantitative information.

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[22] Kunreuther, Howard. "Risk Analysis and Risk Management in an Uncertain World." Risk Analysis, Vol 22, No. 4, 2002 pg 655-658.

This fact brings to the forefront an imperative question: Given the firm can, yet, is not considering probabilities, what motivations or evidence can we provide to justify these calculations? To answer this question, I will rely on the firm's own investments and probability estimates. Arguably one of the most effective mechanisms of demonstrating the need for probability calculations is to provide evidence that current decisions reflect "irrational" probability estimates. Given the detailed cost and basic estimated benefits provided for the recent UPS replacement as well as the "forced" probability estimates, we can not only probe into what probabilities must exist to justify the investment, but then compare those amounts to those provided by the firm. First, we plug in the firms information, including time, cost and discount rate of 12%, into the normative model. The UPS has a useful life of 10 years and the probability estimates, event time frame, is on a per day basis. As a result, we have 365 days multiplied by 10 years to obtain 3650 observations. The model also assumes that only one power outage loss can occur on a single day and that it can also only last for a single day. Later, I will revisit the ramifications of these assumptions. I calculated the weighted average benefit, for a given week, if an entire print day was lost. I assumed that any investment with an ROI > 12%, positive NPV, would be considered.

$$\$249{,}966 = \sum_{t=1}^{3650} \left(\frac{p * \$173{,}142.86}{(1 + 12\%/365)^{t}} \right)$$

Given the benefit figures provided, we must consider what percent of "responsibility" this individual equipment would contribute to resulting lack of production. One method we could assume that only in an extreme event we would expect the total loss to occur (the firm would be unable to produce a paper). So that *p* is not the probability of a power loss, but the probability of an extreme power loss. Alternatively, we could utilize is to assign a percentage, *q*, of benefit the UPS protects. So for example if *q* is 10%, we would conclude that either the failure of the UPS or the non-existence of the UPS would result in an increase in loss equal to 10% of the average daily profit loss. Another way to consider the problem would be that the other existing protective measures would provide 90% protection against the loss, while the UPS is responsible for 10% of that. As a result, the model would have two unknowns. The firm, therefore, would need to either further understand the value of *q* for each investment or assume values of *q* and conduct sensitivity analysis accordingly. The new model would is below.

$$\$249{,}966 = \sum_{t=1}^{3650} \left(\frac{p * (q * \$173{,}142.86)}{(1 + 12\%/365)^{t}} \right)$$

Figure VI provides the calculations using both methods, assuming *q* is equal to 10%. The results state that the probability of an "extreme" power outage would be 0.0679%. While the probability of an average power outage, given a 10% contribution factor, would be 0.679%. Now we must compare those estimates with those provided in the survey by the firm. The firm stated that the probability of a strong strength power surge, more than 2 hours, will occur in a given day ranged from 1/5000 to 1/9999 or 0.02% - 0.01% respectively. This is relatively low to the inherent estimate we calculated, 0.0679%. The difference may result because a power failure of length 2 hours or longer may not constitute an inability to produce a paper. However, we would expect a longer outage to be even less probable, resulting in even further deviations from out calculated estimates. But, our assumptions, one power outage per day that only last for one day, results in a biased estimate. Without this assumption, we would see a larger benefit, resulting in a higher cash flow and therefore a lower probability assumed to support the investment decision. This would move us closer to the estimated probability reported by the firm. If we look at the other mechanisms the calculated estimate of 0.679% falls well within the overall estimate reported 1/100 – 1/1000, or 1% - 0.1%). Given our assumptions, as we discussed before, would most likely still keep us within this range and would in fact move us closer to the ranges average value.

Even with conflicting conclusion, this simple process, which can be easily completed on Excel, provides information that sparks a discussion related the possibility of over-investment. There are also a wide range of other “qualitative” reasons to entice the firm to probe into probabilities. Given the qualitative aspects inherent in the behavioral model, probabilities would also allow decision makers to decrease the influence of “emotions” on the decision making process, reduce the influence of idea origination and politics as well as “unnecessary” event driven responses. The firm could also preemptively avoid losses related to replacement equipment. And most importantly, the firm would be able to understand what gap’s in protection should and should not exist.

Conclusion:

This research has looked at the options available firms to protect against power outage losses, a normative and behavioral model to evaluate those investment opportunities and a case study to further highlight those processes. The case study presented evidence of a firm’s tenancy to display bounded rationality, availability bias, probability neglect and event-driven decisions. One of the more difficult concepts to understand, both from a normative and a behavioral viewpoint, is the underlying ambiguity inherent in low probability events. As a policy recommendation, I recommend that the firm conduct simple analysis to calculate what probability assumptions must be assumed to justify previous investments. There is some evidence that suggest that as the severity of the power outage event increases, so does either the firm’s likelihood of investing in “irrational” protective measures or a decrease in accuracy when reporting actual event probabilities. This later topic deserves much attention and would be an excellent avenue for further research.

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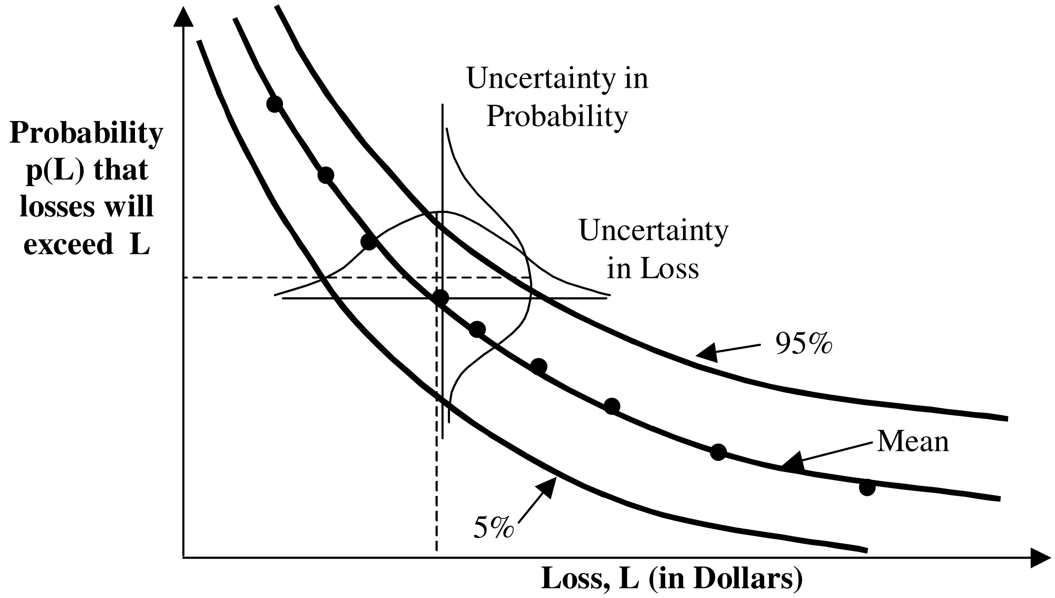
Figure I: Example Of An Exceedance Probability Curve and Confidence Intervals



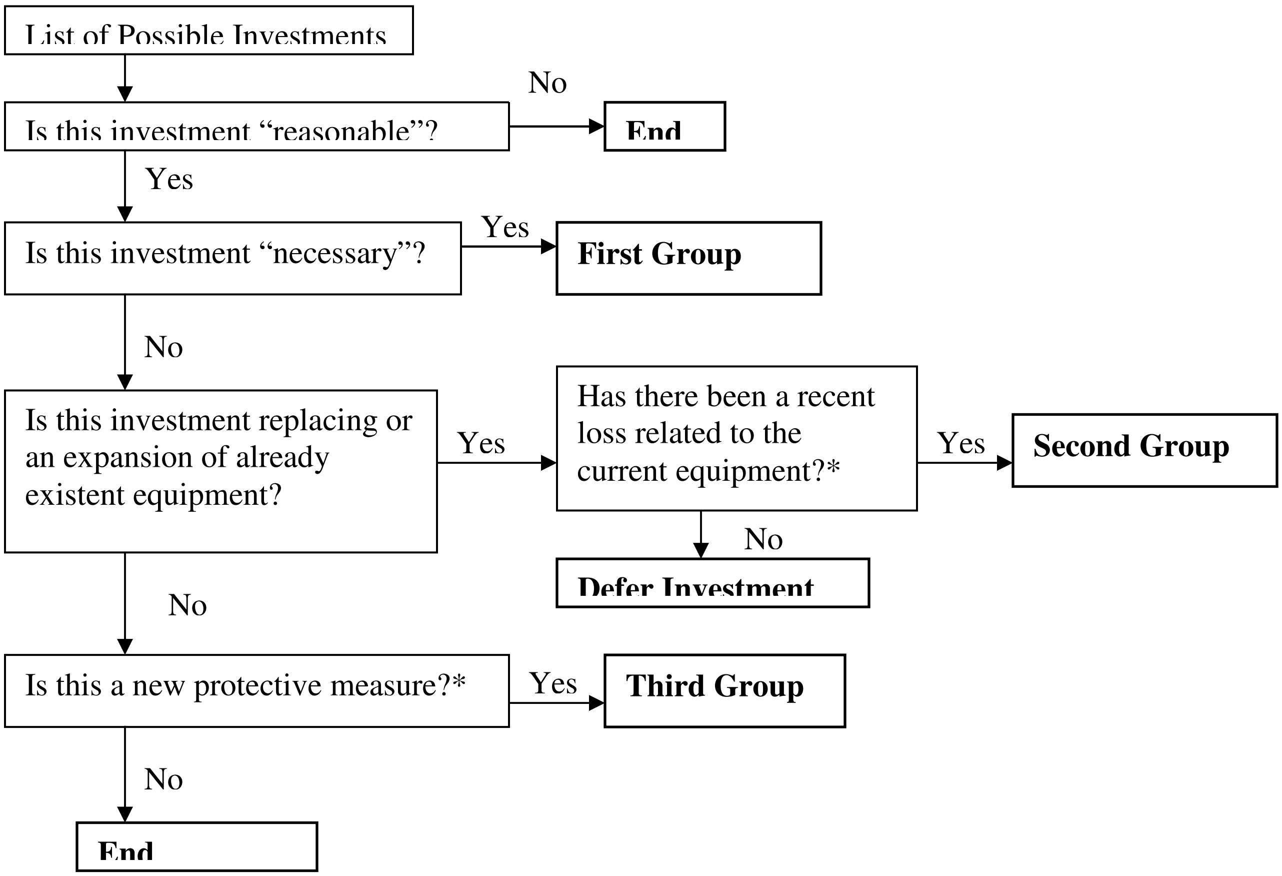
Graphic: Professor Howard Kunreuther

Figure II: Case Study Work-Around for "No Power" Scenario

	No Power						
	1	2	3	1-2	1-2-3	1-3	2-3
8-24 Pages - All Editorial	A			A,C	A,C		
Full w/o zones w/o Class							
Full w/o zones w Class		A,C					
Full w/o Class			B				
Full Product							

A - Assumes generator power is available. Final run would have reduced page/color.
B - If early in the day, ability to create more than the minimum would depend on offsite. AdDesk capability
C - Offsite printing and/or AdDesk contingency

Figure III: Phase One of Behavioral Model - Grouping



* Replacement equipment with recent "severe" losses will be categorized as a necessity and will receive first priority. In addition, new protective measures that are deemed necessary will also receive first priority.

Figure IV: Phase II of the Behavioral Model: Financial Analysis

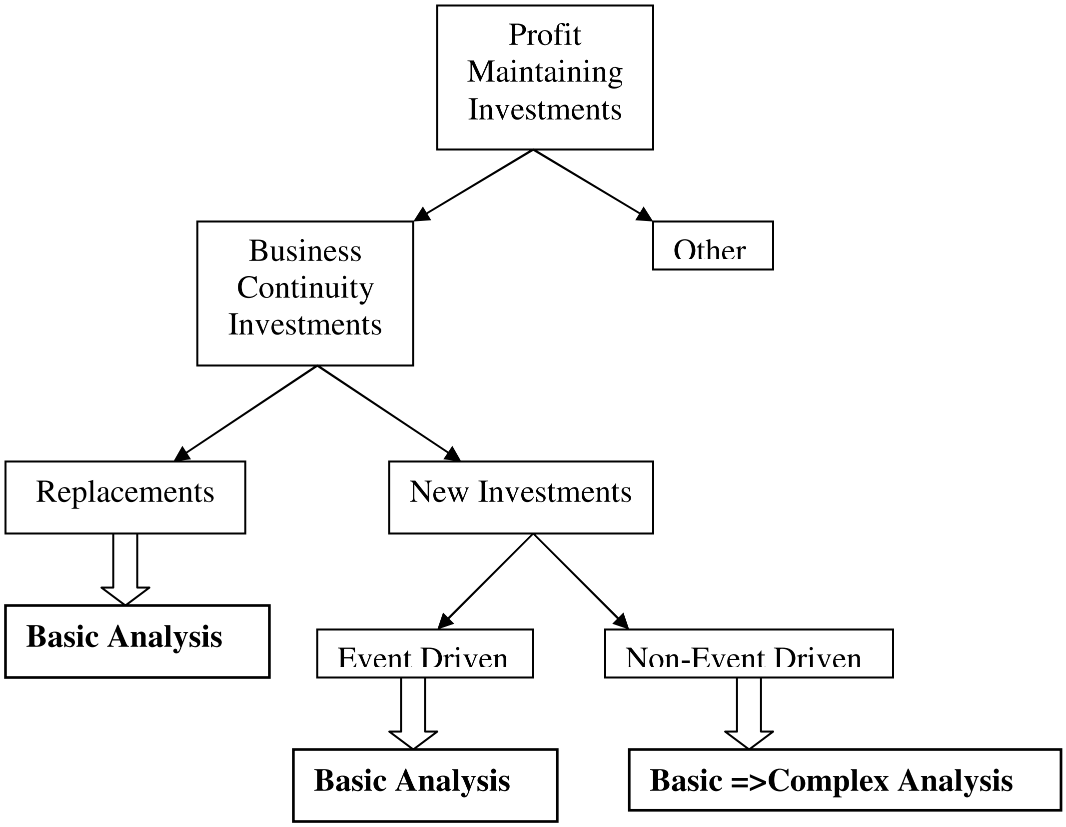


Figure V: Phase Three of Behavioral Model: Budget Constraint and Final Decision

Assumptions:

Yearly Budget Constraint = C^*

Existing Fixed Cost = C_o (including maintenance cost associated with previous investments and other fixed cost)

$C_1 + C_2 + C_3$ are determined from the simple analysis concluded in Part II. These values, however, are not fixed and are depended on the level of protection selected for each investment.

Methodology:

Step 1. Invest in all first priority investments = C_1 (inherent in definition of "necessity")

Step 2. Firm sets budget constraint, C^*, based on needs of C_1, opportunity cost and available investments.

Step 3. If $C_1 + C_o < C^*$ then invest in second priority investments until/at levels** so that

$C^* >= C_1 + C_2 + C_o$

Step 4. If $C_1 + C_2 + C_o < C^*$ then invest in third priority investments until/at levels** so that

$C^* >= C_1 + C_2 + C_3 + C_o$

** If the level of investments becomes "inadequate" due to budget constraints, the project will be deferred.

Figure VI: Probability Calculation

Additional Information –
10 year economic life, event time length based is daily

Cost Summary	Cost	
APC PowerStruxure 40KW (4)	169,444	
APCNetshelter racks (4)	4,700	
APC Smart 620 UPS (2)	556	
Automatic Transfer Switch	10,285	
QOB Circuit breakers	3,015	
Network Connections	5,300	
Installation	30,000	
Contingency (4%)	8,932	
Sales Tax (6%)	13,934	
Shipping	3,800	
Total	**$ 249,966**	
Benefit Summary	**Daily**	**Sunday**
Estimated Total Advertising Loss	91,000	396,000
Estimated Total Circulation Cost Loss (max quoted)	20,000	150,000
Weighted Average	**$ 173,143**	
1. Assume Total Weighted Avearge Benefit: Probability =	**0.0679%**	
2. Assume 10% Likelihood that UPS failure would result in Weighted Average Benefit: Probability =	**0.6793%**	

Resulting equation used to calculate probabilities:
p: probability of event
q: portion of total profit loss that the UPS is protecting

$$\$249{,}966 = \sum_{t=1}^{3650} \left(\frac{p * (q * \$173{,}142.86)}{(1 + 12\%/365)^{t}} \right)$$

Exhibit 1: Case Study Preliminary Survey
Initial Distributed January 30th, 2004
Final Distribution February 5th, 2004
Response: March 2nd, 2004

General Information:
1. Which of the following options has your company **considered** over the past five years **- January 1999 – January 2004** (please select (**IN BOLD TYPE**) all that apply):

- **a. developed a disaster recovery plan (involving some steps to mitigate losses if a power outage occurs)**
- b. **tested your disaster recovery plan**
- c. enter into an interruptible/curtailable service programs[23]
- **d. uninterruptible power source (UPS)**
- **e. back-up generator**
- f. **off-site back-up systems**
- g. entered into or modified existing legal agreements with the state and/or local power company
- **h. other: __agreement for priority generator rental___________________**

2. Which of the following investments have you **actually** made in the past five years (please select **(BOLD TYPE**) all that apply):

- **a. developed a disaster recovery plan (involving some steps to mitigate losses if a power outage occurs)**
- **b. tested your disaster recovery plan**
- c. enter into an interruptible/curtailable service programs
- **d. uninterruptible power source (UPS) (if yes please answer questions 3-7)**
- **e. back-up generator (if yes please answer question 8-12)**
- f. off-site back-up systems
- g. entered into or modified existing legal agreements with the state and/or local power company
- **h. other: ___agreement for priority generator rental___________________**

For Questions, 3-6, please provide your best estimate (e.g. 1/1,000, 1/500). You may also provide a range (e.g. 1/1000-1/9999, 1/10,000-1/100,000).

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3. What is your estimation of the likelihood of a power surge, of any length in time, will occur in a given day? **____1/100-1/1000_________________**

4. What is your estimation of the likelihood of a small strength power surge, 0-10 minute loss of power, will occur in a given day? **__1/500-1/1000___________________**

5. What is your estimation of the likelihood of a medium strength power surge, 10 minutes – 2 hours, will occur in a given day? **__1/1000-1/9999___________________**

[23] interruptible or curtailable service programs are generally programs where organizations obtain discounts in accordance with decreasing their power usage when specified by the power company and/or operating under a specified level

6. What is your estimation of the likelihood of a strong strength power surge, more than 2 hours, will occur in a given day? ___**1/5000-1/9999**_________________

Investment Analysis:
The following questions about your **most recent** investment:

Please provide any additional quantitative or qualitative written, internal information established to support this investment decision. These documents are fundamental to the analysis of power outage protection measures. All internal information will be kept strictly confidential.

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7. What was your most recent investment? (Select 1)
   a. developed a disaster recovery plan (involving some steps to mitigate losses if a power outage occurs)
   b. tested your disaster recovery plan
   c. enter into an interruptible/curtailable service programs
   d. uninterruptible power source (UPS)
   e. back-up generator
   f. off-site back-up systems
   g. entered into or modified existing legal agreements with the state and/or local power company
   h. other: ________________________________

8. Please describe the investment (summary of details/purpose, model, company etc.)
The firm's mission-critical computing systems were supported by a 15-year-old UPS system running on 10-year-old batteries. The components in the existing UPS were dated and difficult to maintain. In addition, the expensive wet-cell batteries had reached the end of their useful life and needed replacement. Furthermore, the total power requirements for the two computer rooms, the Imagesetter room, and the Totalizer system were approaching the maximum supported thresholds on the current Exide 3180 UPS.

There also had been several system outages that threatened the timely production of the newspaper. The most recent outage was a failure of the old UPS system to transfer power to public utility power when an error condition occurred on the secondary unit. A sequence of events then caused a sudden loss of power to computing systems in the second floor computer room.

We purchased zoned APC PowerStruxure UPS systems to provide 80 KW of power for the first floor computer room and 80 KW of power for the second floor computer room. Each zoned UPS system could be expanded to support 1.6 MW of power. In addition, a separate UPS was purchased to supply power to the Press Totalizer system.
The additional purchase of an Automatic Transfer Switch (ATS) provided immediate generator power to the UPS in case of an extended power outage. This project also remediated existing computer room issues with old power panel wiring since the power panels were replaced.

Cost Summary

Major Components	**Cost**
APC PowerStruxure 40KW (4)	169,444
APCNetshelter racks (4)	4,700
APC Smart 620 UPS (2)	556
Automatic Transfer Switch	10,285
QOB Circuit breakers	3,015
Network Connections	5,300

Installation	30,000
Contingency (4%)	8,932
Sales Tax (6%)	13,934
Shipping	3,800

9. What was the date (month and year) of that most recent investment? _July 2002_____

10. Was the investment initiated due to an internal or external event? **Yes** No
If yes, please characterize this event. ___See answer to #8 above for more detail_____

11. Without this investment, how much profit would your organization expect to lose in the given situations? If this type of loss is prevented with due to pre-existing measures please respond: NA (not applicable).

a. small power loss (0-10 minutes): ____minimal*_______________________
b. medium power loss (10 minutes – 2 hours): ___see below*_______________
c. long power loss (more than 2 hours): ___see below*___________________

- If an extended power outage were during production-critical times for the newspaper (e.g. advertising deadlines, editorial deadlines), there could be a significant revenue/profit impact. While we do have back-up generator power, a UPS failure could knock down systems that may take several hours to reboot/repair/refresh (in extreme situations) due to not having a planned or graceful systems shutdown.

- A newspaper is unique in that it manufactures a completely new product every day of the year. It is unlike, for example, razor blade factory that manufactures the same product Monday as it does Tuesday-Friday. So if, for whatever reason, a major disruption were to occur and the newspaper for that day had to be reduced in size (page count) – or not produced at all – revenue for that day could be lost and not recouped at a later date.

- There are significant time of day, day of week, time of year differences with respect to revenue loss (e.g. a Monday UPS failure affecting the newspaper's Tuesday edition does not have the same impact as a failure affecting the Sunday edition). There also is both circulation and advertising revenue at risk. The bullets below show the estimated total profit (not revenue) loss if a paper were not produced due to a major disruption. But please use caution. It is possible that some advertising revenue would be made up in subsequent day(s). It is also likely that a reduced product could be produced at an alternate site, preserving some – if not most – advertising and circulation revenue. It is therefore very unlikely this total daily/Sunday profit loss would occur. Also, a UPS failure in all but the most extreme circumstances would not cause total revenue loss as power would be restored (and systems restored) quickly via generator.

- Estimated Total Circulation Loss $16-20,000 Daily $110-150,000 Sunday
- Estimated Total Advertising Loss $91,000 Daily $396,000 Sunday

12. How much did the initial investment cost? __**$249,966**_________________

13. What is the estimated maintenance cost related to this investment (on a per year basis)? **__minimal (internal electricians**)_______________

14. Are there additional costs (other than initial investment and maintenance cost) associated with the investment? (For example: Is corporate overhead allocated to the investment? Please provide the amount and a description of these costs.)
________No____
____
____
____

15. How many years do you expect this prevention to be in place? **___Estimated useful life is 10 years____________**

16. What is effectiveness, in percentage terms, of this investment? Effectiveness is defined as the probability that if a power outage occurs the product/plan will operate as specified. **___95-100%__________________**

Non-Investment Analysis:

The following questions look at your most recent **analysis** for which your firm opted to **NOT** invest in the protective measure.

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17. What was the most recent option that you analyzed for which you selected not to invest? (Select 1)

i. developed a disaster recovery plan (involving some steps to mitigate losses if a power outage occurs)
j. tested your disaster recovery plan
k. enter into an interruptible/curtailable service programs
l. uninterruptible power source (UPS)
m. back-up generator
n. off-site back-up systems
o. entered into or modified existing legal agreements with the state and/or local power company
p. other: ______________________________

18. Please describe the investment (summary of details/purpose, model, company etc.) **_____We have ongoing discussions regarding the creation of a limited off-site data center to support production-critical systems for our newspaper and Web sites. Several different scenarios have been considered and analyzed over time from $60,000-$100,000 versions to multi-million dollar versions. We do have limited capital budgeted this year ($60,000), which will likely be used to set up a very limited off-site data center at an existing building/bureau. _____**

19. What was the date (month and year) that the investment analysis was initiated?
____

20. Was the analysis initiated due to an internal or external event? Yes No

If yes, please characterize this event. ____
____
____
____
____

21. How much profit would your organization expect to gain in the given situations if this investment would have occurred? If this type of loss is prevented with due to pre-existing measures please respond: NA (not applicable).

d. small power loss (0-10 minutes): ___________________________
e. medium power loss (10 minutes – 2 hours): __________________________
f. long power loss (more than 2 hours): ______________________________

22. What was the expected initial cost? ____________________

23. What is the estimated maintenance cost related to this option(on a per year basis)? __________________

24. Where there additional costs (other than initial investment and maintenance cost) associated with this option? (For example: Is corporate overhead allocated to the investment? Please provide the amount and a description of these costs.)
____
____
____
____

25. How many years do you expect this prevention to be in place? ___________________

26. What is effectiveness, in percentage terms, of this option? Effectiveness is defined as the probability that if a power outage occurs the product/plan will operate as specified. ______________________