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**USING AN EXPERT SYSTEM TO DEBIAS AUDITOR JUDGMENT: AN  
EXPERIMENTAL STUDY**

By

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## **ABSTRACT OF THE DISSERTATION**

### **Using an Expert System to Debias Auditor Judgment: An Experimental Study**

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In the audit profession, judgment and decision making are essential parts of successfully completing an audit. Judgment is a crucial element of the audit process, especially with recent increase in audit regulations. At every step of the audit, auditors are required to make several complex judgments. Psychology and audit research demonstrate that auditors are susceptible to numerous biases, two of which are exacerbated by the accountability inherent in the audit environment. Since the nature of the audit environment requires auditor accountability, this dissertation examines two biases that have been shown to be exacerbated by accountability – the dilution effect and acceptability heuristic bias.

This dissertation consists of three separate essays. Two of this dissertation's essays experimentally examine whether use of an expert system as a decision aid in developing less experienced auditor judgment mitigates these two biases - the dilution effect (Chapter 2) and the acceptability heuristic (Chapter 3) - on auditor judgment in a complex task (fraud risk assessment). An expert system was chosen as the decision aid because research has demonstrated that expert systems have a high level of accuracy, resulting in more appropriate judgments made by less experienced auditors. The third

essay is an exploratory study using process tracing that analyzes the decision making process of less experienced auditors using the expert system in an environment without and with judgment bias present - the dilution effect.

The first essay experimentally examines whether an expert system assists less experienced auditors in making lower fraud risk assessments and mitigates the dilution effect. The dilution effect is a judgment bias which occurs when too much focus is spent on irrelevant information. This bias is exacerbated in auditors when they are knowingly held accountable to their superiors. A solution has yet to be offered to materially reduce this bias.

The second essay experimentally examines whether the use of an expert system as a decision aid mitigates acceptability heuristic. The acceptability heuristic is the shifting towards the preferences of another and adopting a position that is deemed socially acceptable. This bias predominantly occurs when auditors are knowingly held accountable to their superiors. Prior studies have shown less experienced auditors who are aware of the views of audit partners, will align their judgments to agree with that of the partners'. This negative auditor judgment bias has been an area researchers have vastly studied, yet a method to reduce it has not been offered in the literature.

The third essay is an exploratory analysis which uses process tracing to analyze the thought processes of less experienced auditors in making decisions in an environment where a judgment bias occurs - the dilution effect. This essay used a subset of participants from the dilution effect study (Chapter 2) and during the experiment, participants were asked to think aloud to gain further insight into the dilution effect. The think aloud process also captures factors about the process of using the expert system

which contributed towards the mitigation of this bias. Auditor decision making process with and without the use of an expert system will be captured both within and between the participant groups.

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## Chapter One: Introduction

### 1.1 Introduction

In the audit profession, judgment and decision making are essential parts of successfully completing an audit. One of the professional qualifications of the independent auditor states “in the observance of generally accepted auditing standards, the independent auditor must exercise his judgment in determining which auditing procedures are necessary in the circumstances to afford a reasonable basis for his opinion”<sup>1</sup>. Auditors typically employ heuristics in their judgment and decision making which creates certain judgment biases. The heuristic-and-bias approach of decision making used in the audit literature has been adopted from psychology research (Koch and Wüstemann 2009). Researchers have examined these biases in-depth and determined that these same heuristics identified in psychology are applied by auditors in judgments and decision making (Ashton and Ashton 1995).

A major conclusion of auditor decision making research is that auditors are subject to numerous biases, errors, and inconsistencies relative to the recommendations of normative or statistical models; hence, factors to mitigate negative behavioral effects from the biases and improving overall judgments have been studied in-depth (McMillan and White 1993; Ashton and Ashton 1995; Kennedy 1995; Anderson and Maletta 1999; Messier Jr. *et al.* 2001; Peytcheva and Gillett 2011). Researchers have found ways to mitigate the majority of these biases (i.e. procedural tasks, accountability) (Kinney Jr. and Uecker 1982; Kennedy 1993; Reimers and Fennema 1999; Lowe and Reckers 2000;

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<sup>1</sup> Per Auditing Standards 110, paragraph 5, *Responsibilities and Functions of the Independent Auditor*.

Lundberg and Nagle 2002; Harding and Trotman 2009; Koch and Wüstemann 2009), however, some still remain unsolved.

Decision aids are often suggested to mitigate auditor judgment biases. For example, Hoffman and Patton (1997) and Peytcheva and Gillett (2011) suggest the use of a decision aid by auditors can restructure the auditors' task of making judgments in audit procedures. The overall purpose of this dissertation is to determine if the use of a decision aid by less experienced auditors restructures the auditors' task of making fraud risk assessments; and ultimately mitigates these judgment biases that cause less than optimal decisions.

Specifically, the use of an expert system as a decision aid will mitigate negative judgment biases demonstrated by less experienced auditors when held accountable to superiors. An expert system was chosen as the decision aid because previous researchers have suggested with their results that expert systems have a high level of accuracy (Bell *et al.* 1993; Eining *et al.* 1997; Eining and Jones 1997) and using an expert system as a decision aid will increase the appropriateness and effectiveness of the judgments made by less experienced auditors (Libby and Libby 1989; Gal and Steinbart 1987). Two negative biases of interest in this dissertation are the dilution effect (Hoffman and Patton 1997; Glover 1997) and acceptability heuristic (Koonce *et al.* 1995; Peecher 1996; Peytcheva and Gillett 2011). These biases predominantly occur and are shown to be exacerbated in less experienced auditors when they are knowingly held accountable to superiors in explaining their assessment.

In exercising one's judgment, auditors are typically held accountable for their decisions through the review process (Kennedy 1993, 1995; Tan 1995) and accountability

is inherent in the audit environment. Knowing that one is accountable to superiors in justifying his or her judgment usually leads to positive behaviors in the workplace and has mitigated many auditor judgment biases (\*Audit study

Table 1); however, accountability has been shown to create some negative behavioral effects in auditors (Messier and Quilliam 1992), and even exacerbate some of these negative judgment biases. The theory presented in this dissertation addresses these specific negative biases exacerbated by accountability and offers a way to mitigate them.

The dilution effect is a judgment bias in which irrelevant (i.e. nondiagnostic) cues, when processed along with relevant (i.e. diagnostic) cues causes an evaluator to under-weigh the relevant cues (Waller and Zimbelman 2003). This effect has been demonstrated to occur below audit manager level (Shelton 1999), so the current study focused on less experienced auditors. These particular auditor levels (below manager) are also important to examine as they are responsible for the majority of audit field work.

The acceptability heuristic creates a shifting towards the preferences of another and adopting a position that is deemed socially acceptable (Tetlock *et al.* 1989). Prior studies have shown less experienced auditors, who are aware of the views of audit partners', modify their judgments to agree with that of the partners' when being held accountable to superiors (Koonce *et al.* 1995; Peecher 1996; Peytcheva and Gillett 2011). A possible explanation for this is that once an individual makes a judgment and time passes, the individual's memory of that judgment may be weak; leading them to abandon their own judgment once they are aware of superiors' views (Peytcheva and Gillett 2011).

Although prior researchers have examined both of these judgment biases in relation to auditors' judgments (Hoffman and Patton 1997; Waller and Zimbelman 2003;

Hackenbrack 1992; Nisbett, Zukier, and Lumley 1981; Bibbins and Newton 1994; Koonce *et al.* 1995), none have addressed mechanisms that either materially mitigate these biases or explored the role of technology to materially reduce these effects.

This dissertation contributes to the literature in demonstrating that use of an expert system as a decision aid by auditors will reduce the dilution effect and acceptability heuristic, resulting in lower fraud risk assessments. The fraud case used in this dissertation has a low risk for fraud, as evidenced in the case solution, as well as three separate benchmarks. Researchers have highlighted the many benefits in the use and robust need for implementation with regard to expert systems in the accounting profession (Hackenbrack 1993; Eining *et al.* 1997). In response to this need, the expert system AudEx was created for this dissertation. It is specific to fraud risk decision making in the audit industry, but has the capability to be reprogrammed for use in different contexts. The framework for the system was programmed based on specifications provided for the functionality and general design parameters needed for fraud risk assessment capabilities.

It was necessary to create a system which was fully functional, relative to making fraud risk assessments, and can be utilized in the audit industries. Since the accounting and auditing profession is not as advanced as it could be in the successful development and use of intelligent decision aids (Hampton 2005), it was necessary to develop one that far surpassed others that currently existed. Also, the majority of studies incorporating knowledge-based systems have not used a fully functional system, so most previous research was unable to engage the user or impact the behavior of the user (Gregor 2001). Unlike the majority of previous studies designed to affect users' behaviors (Gregor 2001;

Arnold *et al.* 2006), this system was designed to both capture and affect the users' behaviors, examine the use of explanations provided by the system in a decision making environment, and require users to make complex judgments.

Process tracing was also employed as a way to provide further insight into the dilution effect and the effects from using an expert system as a decision aid. By using verbal protocol analysis, one method of process tracing, to analyze the decision making processes of less experienced auditors in an environment where judgment biases exist, a further explanation can be obtained as to why this bias did not occur once they had use of the expert system as a decision aid. Verbal protocols have been found to be the most comprehensive and effective technique in analyzing thought processes and capturing problem definitions, hypothesis development and information search (Todd and Benbasat 1987).

This dissertation is timely due to recent increase in audit regulation, as well as with the profession on the verge of adopting International Financial Reporting Standards ("IFRS"). Research is needed in examining the interaction between auditor regulation and decision aids (Nelson and Hun-Tong 2005). For example, decision aid usage has increased with increased regulations, such as Sarbanes Oxley (Bell and Carcello 2000; Bell *et al.* 2002; Nelson and Hun-Tong 2005). IFRS brings a shift from rules-based to principles-based accounting standards and requires a greater degree of auditor judgment; however, auditors at all levels do not always make the most appropriate decisions. (Hackenbrack and Nelson 1996).

Two separate 2 (x 2) experiments were run, where the first two represents a between subjects manipulation and (x 2) represents a within subjects manipulation.

Overall results from this dissertation support that the expert system mitigated both the dilution effect and acceptability heuristic; as well as show that the less experienced auditors produced lower fraud risk assessments with the use of the expert system. The verbal protocol analysis further supported the results from the dilution effect essay, as well as suggested that audit seniors were mismatching types of risks (i.e. business risks, audit risks, fraud risks). Based on the overall results of the study, the expert system serves as a reliable and appropriate decision aid for auditors' in making assessments in an environment where these biases exist.

The next section focuses on auditor judgment biases and expert systems as decision aids based on previous literature. That is followed by the model used and the overall methodology.

## **1.2 Theoretical Background and Hypotheses Development**

### **1.2.1 Auditor Judgment Biases**

Throughout an audit engagement, auditors are responsible for making various judgments based on data obtained and results of tests during fieldwork. Auditors' ability to develop these judgments and express formal opinions is a large portion of the job requirement, making the audit environment unique. Making appropriate judgments is critical because if proven otherwise auditors may be liable under federal securities laws or common law. Based on the potential liabilities and the uniqueness to the audit environment, much research has been done in the area of auditor judgment and decision making (Joyce and Biddle 1981). This area of research in auditing is drawn from psychology-based theories.

Auditor judgment and decision making research has been concerned with the process of making and the appropriateness of judgments, as well as suggesting

improvements (Solomon and Shields 1995). The main areas of this research are the judgment and decision making process (with the focus on the decision outcome) and the cognitive process (with the focus on the decision process); and the two main variables which affect behavior are individual characteristics (psychological) and environmental.

The concept of heuristics and biases in the judgment and decision making literature was introduced by Tversky and Kahneman (1974). They posit that decision makers rely on a limited amount of heuristic principles. Although useful, these heuristics can lead to errors and biases. Humans, in general, experience several types of decision biases and audit research demonstrates that auditors are prone to these biases. These biases are based on the psychology literature that have been examined in the audit environment (i.e., they are not audit biases, but rather biases that auditors demonstrate).

The five main heuristics used by humans are: (1) representativeness, (2) availability, (3) anchoring and adjustment, (4) framing, and (5) overconfidence. For a summary listing of judgment biases demonstrated by auditors refer to \*Audit study Table 1. The biases are categorized by those five main heuristics. The list was originally obtained from Kennedy (1993) and elaborated on from reviewing previous audit bias literature.

<b>Biases Auditors Demonstrate</b>	<b>Bias Description</b>	<b>Effects</b>	<b>Study</b>
Primacy	Tendency to remember first few things more than the things in the middle and assuming items obtained in the beginning are of greater importance or significance (Tetlock 1983)	Auditors demonstrated bias;  Eliminated with accountability; and  Mitigated with accountability	Anderson and Maletta (1999)*;  Tetlock (1983);  Kruglanski and Freund (1983)
Focusing on irrelevant information due to anchoring effects - Anchoring	Making judgments by establishing some initial value (anchor) and then making adjustments to that value, even if irrelevant (Kruglanski and Freund 1983)	Mitigated with compliance testing; and  Mitigated with accountability	Kinney Jr. and Uecker (1982)*;  Kruglanski and Freund (1983)
Focusing on irrelevant information due to anchoring effects - Confirmation bias	Following a positive test strategy – searching for information that confirms beliefs (Klayman and Ha 1987)	Weakened with conservative bias; and  Mitigated with accountability	McMillan and White (1993)*;  Wheeler and Arunachalam (2008)

Focusing on irrelevant information due to anchoring effects – Information order/Recency	Overweighing information received last in a sequence of inconsistent data (Ashton and Ashton 1988)	Mitigated with accountability	Kennedy (1993)*
Focusing on irrelevant information due to anchoring effects - Hindsight bias	Initial judgment is altered by outcome knowledge (Fischhoff 1975)	No effect with accountability; Mitigated with use of decision aid; and Mitigated with feedback	Kennedy (1995)*;  Lowe and Reckers (2000)*
Self-serving judgment - Overconfidence	Tendency to believe one's judgment is more accurate than it actually is (Lichtenstein <i>et al.</i> 1982)	Mitigated with feedback; and Mitigated with accountability	Harding and Trotman (2009)*;  Tetlock and Kim (1987)
Self-serving judgment – Acceptability heuristic	Shifting towards the preferences of another and adopting a position that is deemed socially acceptable (Tetlock <i>et al.</i> 1989)	Auditors demonstrated bias; and  Exacerbated with accountability	Peytcheva and Gillett (2011)*;  Tetlock (1985a)
Representativeness - Sample size neglect	Neglecting sample size and over relying on sample distribution (Tversky and Kahneman 1974)	No effect with accountability; and  Disappeared after a change in auditing standards	Simonson and Nye (1992);  Messier Jr. <i>et al.</i> (2001)*

Representativeness – Source credibility neglect	Neglecting the credibility of the source of information when judgment is mainly founded on the representativeness of the message (Tversky and Kahneman 1974)	Mitigated - Awareness heighted in role of reviewer	Reimers and Fennema (1999)*
Representativeness - Conjunction fallacy	When two events that can occur together or separately are seen as more likely to occur together than separately (Tversky and Kahneman 1983)	No effect with accountability; and Mitigated with statistical tools	Simonson and Nye (1992); Koch and Wüstemann (2009)*
Representativeness - Ignoring base rates	Relying only on each piece of information individually, and not considering each proportionately to the whole population (Kahneman and Tversky 1973)	No effect with accountability; and Mitigated with statistical tools	Simonson and Nye (1992); Koch and Wüstemann (2009)*
Attribution error effect	Over-valuing personality based explanations for observed behaviors of others while under-valuing situation explanations (Tetlock 1985b)	Auditors demonstrated bias; and Mitigated with accountability	Dezoort <i>et al.</i> (2001)*; Tetlock (1985b)

Sunk cost effect	Continually influenced by initial information even though it is permanently lost and irrelevant in determining future consequences of the current judgment (Simonson and Nye 1992)	Auditors demonstrated bias; and  Mitigated with accountability	Metzger (2011)*;  Simonson and Nye (1992)
Stereotyping	Feeling that individuals from a certain group cannot perform a task as well as another group, which confirms the negative stereotype and causes 'stereotype threat' - resulting in sub-optimal performance (Kruglanski and Freund 1983)	Auditors demonstrated bias; and  Mitigated with accountability	Dambrin and Lambert (2008)*;  Kruglanski and Freund (1983)
Post decision inference	Unconsciously changing information one saw in the pre-decision stage based on outcome feedback – “projecting new knowledge into the past” (Lundberg and Nagle 2002)	Mitigated with Feedback	Lundberg and Nagle (2002)*
Availability effect	Ease of retrieval is the basis for estimating the likelihood of events (Tversky and Kahneman 1973)	Auditors demonstrated bias; and  Mitigated when aware retrieval ease is due to external factors	Brozovsky and Richardson (1998)*;  Schwarz <i>et al.</i> (1991)

Curse of knowledge	The inability to disregard previously processed information (Kennedy 1995)	No effect with accountability	Kennedy (1995)*
Dilution effect	Being overly influenced by irrelevant information (Tetlock and Boettger 1989)	Auditors demonstrated bias; and  Exacerbated with accountability; and  No effect with accountability	Glover (1997)*;   Tetlock and Boettger (1989);

\*Audit study

**Table 1: Auditor Judgment Biases<sup>2</sup>**

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<sup>2</sup> Table adopted from Kennedy (1993) and elaborated on in this study.

Accountability has been shown to either mitigate or have no effect on most of these judgment biases; however, two have been shown to be exacerbated by it - the dilution effect and acceptability heuristic. Most biases which are unaffected by accountability have been mitigated by other means. \*Audit study

Table 1 displays the effect of accountability on auditor judgment biases and identifies those biases that are not mitigated by accountability. The current studies focus on the biases which have been shown to be exacerbated by accountability: dilution effect and acceptability heuristic. Previous research does have some mixed findings regarding the effect of accountability on the dilution effect; however, none have addressed mechanisms that either materially mitigate it or explored the role of technology to materially reduce this effect.

Decision aids have been demonstrated by various researchers as successful in mitigating some of these auditor judgment biases. For example, Rose and Rose (2003) show that use of a computer based decision aid creates consistency among auditor decisions and eliminates the information order bias. Computer based decision aids also improved information order bias (Reneau and Blanthorne 2001). Lowe and Reckers (2000) conduct an experimental study and conclude that a decision aid mitigated hindsight bias. Messier Jr. *et al.* (2001) find decision aids helped to reduce sample size bias.

The current studies are concerned with biases that are exacerbated by accountability. Accountability is a constant variable in the audit environment because throughout the review process of an audit, auditors at every level are held at varying degrees of accountability, whether to regulators, an audit engagement superior, or the

public (Kennedy 1993, 1995 and Tan 1995). These studies also follow previous researchers in employing a decision aid as the tool to mitigate these biases.

### **1.2.2 Decision Aids**

“Advances in technology currently provide the ability to develop decision aids, such as expert systems, capable of supporting the user’s decision process well beyond merely suggesting an outcome” (Eining *et al.* 1997). Also, decision aids have been shown to outperform experts for multi-cue judgments (Libby and Libby 1989). Benefits associated with intelligent decision aids are assisting staff auditors in performing higher-level tasks, reducing decision-making bias, capturing and circulating auditor experience, and learning through explanation capabilities within the intelligent decision aid (Rose 2002; Hampton 2005). As a result of technology advances and reduced cognitive barriers that are identified in individuals making judgments in complex environments (Rose 2002), various professions have adopted the use of decision aids and automated decision support systems (Dowling and Leech 2007).

In order for decision aids to be useful, some degree of reliance must be placed on the aid by the user. Reliance on decision aids is evidenced by decision makers adjusting their judgments based on the assessment of the decision aid (Arnold *et al.* 2004; Dowling 2009). Decision aid reliance decreases in the presence of higher task ability and performance incentives (Ashton 1990) and reliance increases when complexity of the task is greater (Hunton *et al.* 2010; Mascha and Smedley 2007; Arnold and Sutton 1998; Brown and Jones 1998). Hunton *et al.* (2010) perform continuous measures and replicate these findings, as well as demonstrate the positive relationships between: (1) decision aid reliance to task ability – a contradictory finding to the majority of previous research; and (2) forecast accuracy to decision aid accuracy - only for users with low decision aid

reliance. Accurate forecasts are provided by users with high reliance on the decision aid, which is unaffected by the accuracy level of the decision aid (Hunton *et al.* 2010). The current study employed a complex task of developing a fraud risk assessment based on previous studies supporting the notion that reliance increases with task complexity.

Decision aids that make the knowledge and expertise of partners and managers available to all auditors in the firm have the potential of improving auditor judgments of management fraud risk (Hackenbrack 1993; Eining *et al.* 1997; Gillett and Uddin 2005). Numerous studies have been done regarding auditor's use of decision aids (Anderson *et al.* 1995, 2003; Bedard and Graham 2002; Boatsman *et al.* 1997; Dowling and Leech 2007; Seow 2011). Some of these prior studies have compared different decision aids to determine which influences auditors the most in developing assessments and which lead to the more accurate assessments (Eining *et al.* 1997; Eining and Jones 1997). The overwhelming majority of these studies support expert systems as the decision aid of choice when compared to the others.

Dowling and Leech (2007) document audit support systems and decision aids used in audit firms and map them to prior studies. The study also identifies system restrictiveness of different audit support systems. Audit support system restrictiveness is defined as "the extent to which an audit support system constrains auditor behavior through prescribing, organizing and controlling the audit approach" (Dowling and Leech 2007).

Firms classified with a high level of auditor support system restrictiveness had a more structured and rigid decision aid embedded into the system. These same decision aids within high restrictive systems are capable of tailoring audit files and providing

recommendations based on auditor responses to questions in checklists. For example, recommendations include tests of controls, effectiveness of controls, and relevant audit tests. The low restrictive systems generally do not have the ability to give recommendations. The types of decision aids identified at the firms with high levels of restriction are electronic 'file check' highlights of incomplete areas and disclosure checklists. None of the decision aids used at any of the firms provided an audit opinion.

In an experimental study, Eining *et al.* (1997) compare different levels of decision aids – none, expert systems, checklists, and statistical models - to determine which influences auditors most in assessing management fraud risk, and then determine appropriate subsequent actions. Results demonstrate that auditors make more accurate assessments with the use of expert systems as a decision aid over other types of decision aids, as well as no use of decision aids. The use of expert systems leads to more appropriate subsequent planning and procedures that are consistent with the assessments made regarding management fraud risk.

Eining and Dorr (1991) evaluate the use of an expert system as a decision aid on the novice auditor's learning. The four levels of decision aid treatment are: (1) no decision aid, (2) questionnaire, (3) expert system without explanatory capability, and (4) expert system with explanatory capability. Participants who had use of an expert system (without and with explanatory capability) performed significantly better than participants without any decision aid and with a questionnaire.

An expert system is the decision aid of choice in the current study because they have been shown to outperform other decision aids in assisting auditors in developing more appropriate assessments (Eining and Jones 1997; Eining and Dorr 1991). Use of a

computerized decision aid reduces cognitive load and allows users to acquire more knowledge by integrating explanations throughout the process of developing a decision (Rose and Wolfe 2000). Two fundamental differences between expert systems and other decision aids are that expert systems: (1) place emphasis on rules-based knowledge, not algorithms, and (2) provide the user access to this knowledge base. Also, decision aids have been shown to outperform experts for multi-cue judgments (Libby and Libby 1989). Therefore, decision aids that make the knowledge and expertise of partners and managers available to all auditors in the firm have the potential of improving auditor judgments of management fraud risk (Hackenbrack 1993; Eining *et al.* 1997; Bell and Carcello 2000).

### **1.2.3 Expert Systems as Decision Aids**

Prior studies have compared different decision aids to determine which influences auditors the most in developing assessments and which lead to the more accurate assessments (Eining *et al.* 1997; Eining and Jones 1997). Results demonstrate that auditors make more appropriate assessments with the use of expert systems as a decision aid over other types of decision aids, as well as no use of decision aids.

Expert systems are “computer programs that capture knowledge and make recommendations much like human experts” (Foltin and Garceau 1996). They are designed to mimic human decision making processes and contain a rules-based structure. Expert systems have the ability to explain the reasoning and logic behind a decision, why certain questions are posed, and why an option is eliminated (Etheridge and Brooks 1994). The expert system developed and used in the current study is actually trained (i.e. input company information, historical data, etc.) by audit partners and managers; hence, less experienced auditors using this specific decision aid can learn and be trained from the system as if it was the actual partner or manager on the job.

Research on the use of expert systems in accounting and auditing is extensive and findings generally suggest that expert systems enhance decision making (Gal and Steinbart 1987; Borthick and West 1987). Expert systems have been shown to have an overall positive effect on company performance, decision making, and serve as a learning tool (Mauldin 2003; Elmer and Borowski 1988). For example, Eining and Dorr (1991) evaluate the use of an expert system as a decision aid on the novice auditor's learning. Participants who had use of an expert system performed significantly better than participants who did not have use of an expert system.

Using an expert system as a decision aid can mitigate the judgment biases occurring in auditors when accountability is present because expert systems serve as learning tools, take the auditor interactively and methodically through the decision making process, force the auditor to justify one's assessment, and provide a means of support to the auditor in developing a final judgment. The audit environment in relation to judgment and decision making is more complex currently than it has been in the past. This is partially due to the increased emphasis on fraud risk assessments<sup>3</sup>, the recent change to a risk based audit approach<sup>4</sup>, and increase in audit regulation. Advances in technology make it possible to develop expert systems capable of supporting the auditor's decision process, not just suggest an outcome (Eining *et al.* 1997). Therefore, it is expected that auditors who use expert systems as a decision aid will provide more appropriate judgments more in-line with experts in the field (managers and partners), while having mitigated judgment biases.

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<sup>3</sup> AU section 316 (formerly SAS No. 99) Consideration of Fraud in a Financial Statement Audit.

<sup>4</sup> AU sections 230.10, 150.02, 326, 9326, 312, 9311, 314, 318, 350, and 9350 (formally SAS No. 104-111) – all relating to the risk based approach audit.

### 1.3 Expert System Model

The expert system used in the current study, AudEx, is specific to fraud risk decision making in the audit industry. The framework for the system was programmed based on specifications provided for the functionality and general design parameters needed for fraud risk assessment capabilities. This expert system is a fully functioning system relative to fraud risk assessments, not just a simulation of what the system would do if it were operational. Refer to Appendix C: AudEx (Audit Data Assessment System) for details on the audit data assessment system, AudEx. Unlike the majority of previous studies designed to affect users' behaviors (Gregor 2001; Arnold *et al.* 2006), this system was designed to both capture and affect the users' behaviors, examine the use of explanations provided by the system in a decision making environment, and require users to make complex judgments. A fully functioning system has been shown to influence novices' and experts' judgments (Arnold *et al.* 2006).

Technology is continually advancing and its use is now more widespread (Hwang *et al.* 2004). This particular expert system captures the improvement in technology because it is an ultimate hybrid system (i.e. expert system, neural network, fuzzy logic, etc.) and is trained by human experts. In this training, technology advancement is captured and accounted for by the system. This is done by the system retaining data provided and work performed that the expert input, as well as rules, regulations, and procedures manually inputted into the system. With this training, the system can produce the same assessments the actual auditor would have produced. The system can perform more efficiently and less costly in the long-run (Borthick and West 1987), while creating a substantially raised base line and consistent audit that can then be reviewed by the actual auditor.

The system includes constructive dialog (Eining *et al.* 1997). Constructive dialog creates conversation in which the participants' primary purpose is learning and understanding. Eining *et al.* (1997) use this phrase as a way to identify the features of the system that improved the decision making process and increased reliance on the decision aid. With the inclusion of constructive dialog the auditors learn and are forced to justify rationale in developing their assessment. A validation of the expert system was performed by pilot testing the experiments using graduate level auditing students and audit managers and partners.

#### **1.4 Methodology**

Two individual laboratory experiments were conducted to examine the influence of the use of the expert system on the assessment and evaluation of an audit fraud risk scenario by less experienced auditors. Each bias, dilution and acceptability, was tested individually in Chapters 2 and 3, respectively. Chapter 4 uses a subset of participants from the dilution effect experiment (Chapter 2), but asked those participants to think aloud in order to analyze individuals' thought processes involved in decision making and identify factors that led to overcoming the bias.

The first study experimentally examined whether use of an expert system would mitigate the dilution effect (Figure 1). A 2 (x 2) design was employed. The type of information (relevant only information or relevant and irrelevant information) was manipulated between groups. Use of the expert system was a within subjects variable with participants first making a decision without the expert system and then revising their decision after completing the case with the assistance of an expert system.

The second study experimentally examined whether use of an expert system would mitigate the acceptability heuristic bias (Figure 3). The experiment was a 2 (x 2)

design with expert system (no use of expert system and use of expert system) manipulated between groups. Learning partner's views was manipulated within subjects. Learning partners' views always occurred after the auditor made an initial judgment.

The last study was an extension of the experiment used in the dilution effect study and the only difference with this subset of participants from the others in the dilution effect study were that participants were told to think aloud throughout the entire experiment. This exploratory study was done in order to capture and compare the different thought processes of less experienced auditors in an environment without and with the presence of this judgment bias, as well as without and with the use of the expert system. The transcripts were analyzed using verbal protocol analysis, a method of process tracing, in order to identify different trigger points which may account for the rationale of why this bias occurs and the factors which contributed to mitigation of the bias.

The next three chapters experimentally examine the dilution effect and the acceptability behavior. The last chapter presents an overall conclusion and discussion, followed by future research suggestions, and limitations of the studies.

## **Chapter 2: Using an Expert System to Debias the Dilution Effect in Auditor Judgment**

### **2.1 Introduction**

Previous researchers have shown that the use of expert systems as decision aids by auditors improves assessments (Gal and Steinbart 1987; Borthick and West 1987; Eining and Jones 1997). This finding has yet to be applied in significantly reducing the dilution effect. The dilution effect is a judgment bias which occurs when too much focus is spent on irrelevant information. More specifically, it is a judgment bias in which irrelevant (i.e. nondiagnostic) cues, when processed along with relevant (i.e. diagnostic) cues causes a decision maker to under-weigh the relevant cues (Waller and Zimbelman 2003).

The purpose of this study is to experimentally examine the use of a decision aid tool by less experienced auditors to mitigate the dilution effect. The expert system AudEx is used as the decision aid by the auditors in the context of making fraud risk assessments. It includes constructive dialog, adopted from Eining *et al.* (1997). Constructive dialog creates conversation in which the participants' primary purpose is learning and understanding. Eining *et al.* (1997) use this phrase as a way to identify the features of the system that improved the decision making process and increased reliance on the decision aid.

This effect has been demonstrated to occur in less experienced auditors (Shelton 1999), so the current study focused on senior level auditors. This particular auditor level is also important to examine as it is responsible for the majority of audit field work, including making fraud risk assessments. This negative behavioral effect, in relation to auditors' judgments, has been an area researchers have vastly studied. The

overwhelming consensus is that the dilution effect does occur in less experienced auditors when faced with relevant and irrelevant information (Quilliam 1993; Hackenbrack 1992; Buchman *et al.* 1994).

If a knowledge-based expert system is utilized in auditor judgment and decision making, the dilution effect may be reduced. The use of a decision aid would prompt auditors to focus attention on the relevant information and help them to screen out irrelevant information (Hoffman and Patton 1997). An expert system was chosen as the decision aid because previous researchers have suggested that expert systems have a high level of accuracy (Bell *et al.* 1993) and using an expert system as a decision aid will increase the effectiveness of the judgments made by less experienced auditors (Libby and Libby 1989; Gal and Steinbart 1987).

A laboratory experiment was conducted to examine the influence of the use of the expert system on the assessment and evaluation of management fraud in reducing the dilution effect. A 2 (x 2) repeated measure design was employed in this study. The type of information (relevant only information or relevant and irrelevant information) was manipulated between groups. Use of the expert system was a within subjects variable with participants first making a decision without the expert system and then revising their decision after completing the case with the assistance of an expert system. All participants knew they were being held accountable in their assessments and had to justify the evaluations.

This study contributes to the literature on auditor judgment and decision making by demonstrating that use of an expert system as a decision aid to less experienced auditors making fraud risk assessments can reduce the dilution effect. Although prior

researchers have examined the dilution effect in relation to auditors, they have not explored the role of expert systems to reduce this effect. This study also contributes to the research on fraud risk assessments which has demonstrated that auditors find it difficult to assess the likelihood of management fraud. Making fraud risk assessments are important because "too weak a response could jeopardize the effectiveness of the audit (i.e. could fail to uncover existing fraud) and too strong a response could result in an inefficient audit" (Eining *et al.* 1997). Lastly, this expert system, AudEx, was developed as a decision aid in making fraud risk assessments. It was necessary to create a system which was fully functioning and can be utilized in the audit industries. A fully functioning system has been shown to influence novices' and experts' judgments (Arnold *et al.* 2006). Currently, a system like this one is not available in the audit industry and has not been used in audit fraud risk assessment literature.

The next section presents the theory and the hypotheses developed. The third section describes the methodology and research design. The fourth section explains results and the last section contains the conclusions.

## **2.2 Theoretical Background and Hypotheses Development**

### **2.2.1 Biases in Auditor Judgment Exacerbated by Accountability**

One negative behavior exhibited by auditors exacerbated, not mitigated, by accountability is the dilution effect, which is the focus of the present study. While this negative bias occurs regardless of accountability, some previous studies have shown that accountability exacerbates the dilution effect in auditors (Quilliam 1993; Hackenbrack 1992; Buchman *et al.* 1994). This is because when auditors are knowingly held accountable to superiors they concentrate more on irrelevant information than they would have and their judgments are more conservative, as opposed to when they are

unaccountable (Morton and Fleix 1991; Lord 1992; Buchman *et al.* 1994; Quilliam 1993). For a complete description of auditor biases and the effects of accountability refer to \*Audit study

Table 1.

Accountability of one's judgment is an essential feature of most natural decision making environments (Tetlock 1985a; Messier and Quilliam 1992) and equally important in auditors' judgment making environment (Gibbins and Emby 1984). The audit environment forces the professional auditor to justify, document, and take responsibility for one's judgments and decisions (Ashton *et al.* 1989 and Buchman *et al.* 1994). The audit environment is unique compared to others in that it is subject to rigid external controls through regulators, such as the Financial Accounting Standards Board and the Securities and Exchange Commission, and held accountable to the public (Rahman and Zanzi 1995). Also, there is a multi-person character present in the audit environment, as the majority of audits are conducted by a team of auditors, not individually (Solomon 1987). Research suggests auditors may be different types of decision makers in different environments (Payne 1982).

Other audit studies support the predictions of the social contingency model regarding accountability (Tetlock and Boettger 1989; Tetlock 1983 and 1985a). The social contingency model contains three interrelated assumptions: (1) accountability is a universal feature of decision making on worldly issues (Emby and Gibbins 1988); (2) those making decisions, especially in organizations, want approval and respect from those who hold them accountable (Pfeffer 1981); and (3) those making decisions use

several cognitive strategies to deal with accountability in the social-organizational environment (Buchman *et al.* 1994).

### **2.2.2 The Dilution Effect**

The dilution effect is “a judgment bias in which the presence of nondiagnostic (i.e. irrelevant) cues, when processed along with diagnostic cues, causes a judge to underweigh the diagnostic cues” (Waller and Zimbelman 2003). According to Hoffman and Patton (1997), this judgment bias is not expected to be corrected by putting additional effort in performing a task (i.e. a perceptual problem). Decision makers in general tend to put weight on all types of provided information and this unnecessary attention and weighing causes judgments to not meet their potential (Jones *et al.* 2006).

The dilution effect serves as an explanation as to why individuals use irrelevant information in making predictions (Nisbett *et al.* 1981; Zukier 1982). Prior research suggests that individuals’ predictions significantly reflect the data provided when it is relevant; however, when irrelevant information is presented, the predictions are minimally influenced by the relevant information (Igou and Bless 2005; LaBella and Koehler 2004). For example, when participants are provided with positive or negative diagnostic (i.e. relevant) information about a product, the judgments are more favorable with positive diagnostic information; however, when nondiagnostic (i.e. irrelevant) information is included, the diagnostic information’s impact on the participant is diluted, even when the nondiagnostic information’s applicability is questioned (Zukier 1982; Igou and Bless 2005).

Some previous research has also demonstrated that as accountability increases the dilution effect (Tetlock and Boettger 1989). One rationale provided by Tetlock and Boettger (1989) for this relationship is that accountable individuals tend to use more

integrative complexity to process information than unaccountable individuals. Integrative complexity is “an individual’s tendency to think about various perspectives of an issue in an integratively complex manner” (Haugtvedt *et al.* 2008). The two cognitive properties it possesses are differentiation and integration. Tetlock *et al.* (1996) claim integrative complexity serves as a mediator in judgment.

Researchers have shown that individuals can clearly distinguish between the relevant and irrelevant information; yet still experience this effect (Meyvis and Janiszewski 2002; Kimmelmeier 2004; Igou and Bless 2005). One reason for this anomaly is that individuals do not realize the extent of influence irrelevant information causes in their assessments because they are capable of knowingly distinguishing between relevant and irrelevant information. For example, Humphrey (1997) purports that individuals are unaware of cognitive processes used in developing their evaluations; and the individuals actually believe that their evaluations were most influenced by quality (i.e. relevance) of information, not quantity.

The claims made by previous researchers - that individuals, in general, can clearly distinguish between relevant and irrelevant cues - holds true for auditors as well. For example, less experienced auditors are able to differentiate between relevant and irrelevant indicators of fraud, yet still experience this effect (Hoffman and Patton 1997). More experienced (manager level and superior) auditors tend to focus on the relevant information and ignore the irrelevant information, while less experienced auditors do not seem able to do so even though they recognize that the information is irrelevant (Shanteau 1993; Lesgold *et al.* 1988). This is because more experienced auditors use strategies to obtain relevant only information, while less experienced auditors

sequentially examine information, exposing them to irrelevant and relevant information (Biggs and Mock 1983).

The dilution effect in auditing has predominantly been researched with regards to decision making and judgment development and results show auditors do experience this effect when faced with relevant and irrelevant information (Eining and Dorr 1991; Hackenbrack 1992; Hoffman and Patton 1997; Eining *et al.* 1997; Eining and Jones 1997; Waller and Zimbelman 2003). This negative behavioral effect leads to auditors spending excessive time developing inappropriate judgments, which results in increased time and costs due to excessive and inefficient auditing.

Research on the dilution effect relating to auditors' judgments on assessing fraud risk has been addressed by various authors (Hackenbrack 1992; Nisbett *et al.* 1981). Hackenbrack (1992) demonstrates that when presented with relevant and irrelevant information, auditors made more conservative fraud risk assessments than when presented with relevant only information. In this case fraud was present and auditors used irrelevant information in making their assessment. This is due to the auditors experiencing the dilution effect.

Auditors lean towards making conservative judgments based on the audit environment and their training; however, this may lead to their failing to uncover material errors (Smith and Kida 1991). Auditors tend to think that making more conservative judgments will be easier to justify to superiors, whether appropriate or not (Morton and Felix 1991).

Seow (2009) uses simple decision aid checklists to assist auditors in making fraud risk assessments when diagnostic and nondiagnostic cues are present. Auditors make

higher fraud risk assessments when they identify and process more diagnostic than nondiagnostic factors. The identification and processing of nondiagnostic factors led to diluted risk assessments made by the auditors. Seow (2009) concluded that generic decision aids are not the solution in assisting auditors in making fraud risk assessments.

Some previous studies have examined other factors (i.e. time pressure and experience) that may reduce the dilution effect in auditors, but they find that these do not result in a significant reduction. Glover (1997) extends Hackenbrack's (1992) study and examines how auditor judgment is influenced by nondiagnostic information. Glover's results are similar to Hackenbrack's, in which it is determined that the dilution effect is exhibited. This study uses a laboratory setting and examines auditors when they are subject to time pressure and accountability. Time pressure does not eliminate the dilution effect, but it does reduce it; however, not enough to have a material impact on decision making. Glover did find that accountability neither exacerbated nor mitigated the dilution effect, which is also a finding Hoffman and Patton (1997) demonstrate.

Although the findings (accountability neither exacerbating nor mitigating the dilution effect) demonstrated in these two studies contradict what the current study is purporting, accountability is inherent in the audit environment and the auditors in the current study are held accountable to resemble the realities of the audit environment. Regardless of the mixed findings (accountability either exacerbating or having no effect on the dilution effect) relating to the effects from accountability on the dilution effect, less experienced auditors do experience the dilution effect when faced with relevant and irrelevant information; whether or not they are held accountable (Eining *et al.* 1997; Shelton 1999).

Prior literature supports the dilution effect occurring in less experienced auditors (i.e. audit seniors), but does not show the dilution effect occurring in experienced auditors (i.e. audit managers) (Shelton 1999). Shelton (1999) examines whether auditors' experience moderates the dilution effect of irrelevant information on auditors' judgments. This is done by comparing audit seniors' with audit managers' and partners' going-concern judgments when irrelevant information is present along with relevant. Results show that audit seniors experience the dilution effect, but the audit managers and partners do not experience that effect.

Based on the above research, less experienced auditors and fraud risk assessments were the focus of the current study. Previous researchers have repetitively shown that the dilution effect occurs in less experienced auditors when knowingly held accountable to superiors; therefore, the present study uses this as a baseline and does not aim to replicate these findings.

### **2.2.3 Expert Systems as Decision Aids**

Benefits associated with intelligent decision aids are assisting less experienced auditors in performing higher-level tasks, reducing decision making bias, capturing and circulating auditor experience, and learning through explanation capabilities within the intelligent decision aid (Rose 2002; Hampton 2005). Expert systems allow for improved judgment and decision quality, as well as reduced cognitive barriers found when individuals are making judgments in a complex environment (Rose 2002). Previous studies have shown that less experienced auditors who are held accountable to their superiors tend to make more conservative judgments when the task is complex (Morton and Felix 1991; Lord 1992; Buchman *et al.* 1994; Quilliam 1993; Peecher 1996). The current study uses a fraud risk scenario as the complex task for less experienced auditors

to make an assessment. Making fraud risk assessments is a complex task that auditors are responsible for on every audit and prior research supports that less experienced auditors assess fraud risk more conservatively (higher fraud risk assessments) when held accountable to superiors (Smith and Kida 1991; Hoffman and Patton 1997).

Expert systems are “computer programs that capture knowledge and make recommendations much like human experts” (Foltin and Garceau 1996). They are designed to mimic human decision making processes and contain a rules-based structure. Unlike other decision aids, expert systems: (1) place emphasis on rules-based knowledge and (2) provide the user access to this knowledge base. Expert systems explain the rationale behind a decision, as well as the reason why specific questions are asked and certain options are eliminated (Etheridge and Brooks 1994).

Expert systems have been shown to influence novices’ and experts’ judgments (Arnold *et al.* 2006). Previous research has shown that decision aids which make the knowledge and expertise of partners and managers available to all auditors in the firm have the potential of improving auditor judgments of management fraud risk (Hackenbrack 1993; Eining *et al.* 1997; Bell and Carcello 2000; Gillett and Uddin 2005).

The above research suggests the following hypotheses:

**H1:** Less experienced auditors will make lower fraud risk assessments when using the expert system as compared to not using the expert system.

Research on the use of expert systems in accounting and auditing is extensive and findings generally suggest that expert systems enhance decision making (Gal and Steinbart 1987; Borthick and West 1987). Expert systems have been shown to have an overall positive effect on company performance and decision making, serve as a learning tool, and capable of knowledge transfer from experts to novices (Smedley and Sutton

2004, 2007; Mauldin 2003; Elmer and Borowski 1988). For example, Eining and Dorr (1991) evaluate the use of an expert system as a decision aid on less experienced auditor's learning. Participants who had use of an expert system performed significantly better than participants who did not have use of an expert system. Also, Gal and Steinbart (1987) find use of expert systems in accounting reduce costs and improve decision making. Lenard (2003) demonstrates that when expert systems apply analogies and declarative explanations, the novice auditor develops a more appropriate understanding of internal controls involved with audit planning.

Based on the existing research, expert systems help less experienced auditors in making more complex decisions and serve as learning tools; therefore, I expect that an expert system would mitigate the dilution effect. If the dilution effect can be mitigated by using the expert system in making a complex decision, then the fraud risk assessments made by less experienced auditors should be lower when made with the expert system than without the expert system.

Using an expert system as a decision aid can mitigate the dilution effect occurring in auditors when accountability is present because expert systems serve as learning tools, take the auditor interactively and methodically through the decision making process, force the auditor to justify one's assessment, and provides a means of support to the auditor upon developing one's final judgment (Gal and Steinbart 1987; Mauldin 2003). Previous studies have also suggested that the use of a decision aid by auditors can restructure the auditors' task of making judgments in audit procedures (Hoffman and Patton 1997; Peytcheva and Gillett 2011); hence reducing judgment bias. A knowledge-

based expert system that prompts auditors to focus their attention on relevant information will help them to screen out irrelevant information (Hoffman and Patton 1997).

Based on the above research:

**H2:** Using an expert system as a decision aid reduces the dilution effect experienced by less experienced auditors.

Although expert systems as decision aids have been demonstrated to successfully assist auditors in developing assessments, some level of reliance on and feasibility of the decision aid by the user is needed to achieve success (Arnold *et al.* 2004). Decision aid reliance decreases in the presence of higher task ability and performance incentives (Ashton 1990) and reliance increases when complexity of the task is greater (Arnold and Sutton 1998; Brown and Jones 1998; Hunton *et al.* 2010). Accurate forecasts are provided by users with high reliance on the decision aid, which is unaffected by the accuracy level of the decision aid (Hunton *et al.* 2010). The current study employed a complex task of developing a fraud risk assessment based on previous studies supporting that reliance increases with task complexity.

Arnold and Sutton (1998) compile results from prior studies involving the use of decision aids by novice auditors, and find overall reliance by auditors on decision aids. Specific studies examined which decision aids users placed the most reliance on and expert systems had the highest reliance (Eining *et al.* 1997; Changchit *et al.* 2001).

Another factor that may impact the use of expert systems as decision aids is technology dominance. Arnold *et al.* (2004) define technology dominance as “the state of decision-making whereby the decision aid, rather than the user, takes primary control of the decision-making process”. Recognizing this as a potential problem, the expert

system used in the current study forces the auditor to analyze and justify decisions made and the system does not provide an overall fraud risk assessment to the participant. This avoids the decision aid taking primary control of the user in making the decision because the user must provide rationale to justify his final decision, as well as is not given the overall assessment per the expert system.

## **2.3 Methodology and Research Design**

### **2.3.1 Participants**

Audit seniors from a regional public accounting firm were selected as participants, because prior research has shown that the dilution effect did not occur with managers and partners (Shelton 1999). There were 46 participants who averaged 4.2 years of experience, were all involved in the fraud risk assessment process (averaging 8.13 fraud risk assessments made in the last three years), and familiar with Statement on Auditing Standards ("SAS") 99 and the checklist that supports it. This information was obtained from participants completing a post-experimental information form. A subset of 12 participants (included in the 46 participants) were instructed to talk aloud during the experiment in order to perform a verbal protocol analysis (Chapter 4). Although these 12 participants spoke aloud, there were no significant differences between either of the fraud risk assessments (without use of the expert system or with use of the expert system) when compared to participants who did not think aloud<sup>5</sup>.

All participants were held accountable for their assessments and had to justify the final judgments by providing explanations and support for their assessment; regardless if the assessment had been changed from the initial assessment. Participants were

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<sup>5</sup> The 12 participants' assessments were analyzed both individually and with the group as a whole and there were no significant differences; hence, the 12 participants did experience the dilution effect without use of the expert system and the effect was later mitigated with use of the expert system.

prompted to input their names as part of the user log-in by the computer and experimenter. This was to insure accountability was employed consistent with previous studies (Peecher 1996; Lord 1992; Peytcheva and Gillett 2011).

Participants from the public accounting firm were randomly split into two condition groups - relevant only information or relevant and irrelevant information - and had to assess the risk of fraud on the provided case study. For credibility purposes, participants were told that the firm had already implemented this expert system and wanted to obtain feedback from employees. Participants inputted all data into a computer.

### **2.3.2 Experimental Design**

A laboratory experiment was conducted to examine the influence of the expert system as a decision aid on the assessment and evaluation of management fraud. This experiment was conducted at the home offices of participants in a controlled laboratory environment. The experimenter was present during the experiment. The experiment employed a 2 (x 2) repeated measure design. The type of information (relevant only information or relevant and irrelevant information) was manipulated between groups. Use of the expert system was a within-subjects variable with participants first making a decision without the expert system and then revising their decision after completing the case with the assistance of an expert system (Figure 1 and Figure 2).

	<b>Expert System</b>
<b>Relevant Only Information</b>	<b>1</b>
<b>Relevant and Irrelevant Information</b>	<b>2</b>

	<b>Relevant Only Information</b>	<b>Relevant and Irrelevant Information</b>
<b>Part One (No Expert System)</b>	Case evidence	Case evidence
	Make initial judgment	Make initial judgment
<b>Part Two (Expert System)</b>	Use expert system in developing final judgment	Use expert system in developing final judgment
	Submit final judgment	Submit final judgment

**Figure 1: Dilution Effect: Experimental Design**

**Figure 2: Flow of Experiment - Dilution Effect**

There were two different versions of the case study and each condition group received one version. The participants in the relevant only information condition group obtained only relevant information cues (6 relevant cues), and the participants in the relevant and irrelevant information condition group obtained all of the relevant cues, as well as some irrelevant information cues (6 relevant and 4 irrelevant cues). The participants were first asked to develop an initial assessment and rate the factors that contributed to that assessment. This was done without use of an expert system.

The expert system then took the participants through a series of questions, in line with the SAS 99 fraud indicators, containing cues all relevant to indicating fraud, but only some were present in the specific case. That was followed by the expert system taking participants through a comparison of participant's and expert system's assessments of each fraud risk indicator, with the expert system stating rationales and sources (i.e. SAS 99) used overall in assessing each indicator.

Lastly, the system reminded participants of their initial assessment and asked if they would like to change their evaluation. The system did not provide an overall fraud risk assessment to the participant, as to avoid creating another bias, the acceptability heuristic. If the less experienced auditor learned the assessment of the system, literature has shown they will align with that assessment (Peytcheva and Gillett 2011). Also, since the system did not tell participants the appropriate fraud risk assessment, it suggests that the participants changed from their initial fraud risk assessment due to the process of using the expert system and learning from using the system. Hence, they did not just change their fraud risk assessment because they learned the expert system's assessment.

Ultimately, the overall fraud risk assessment needed to be justified by the participants providing an explanation to support the final fraud risk assessment, regardless if the initial fraud risk assessment was revised. At the end of the experiment, participants were shown the expert system's overall fraud risk assessment compared to their own; however, were not able to make any changes. Lastly, participants were asked to provide feedback and demographical information via a post experiment questionnaire.

There were two reasons the experiment was designed in this way. First, this experiment was meant to mimic the real-life process of assessing fraud risk on an audit, so the participants were able to relate to the steps in the process during the experiment. Second, a similar method was used by Hunton *et al.* (2010) with the purpose of capturing reliance on the decision aid. Hunton *et al.* (2010) captured this by having the participants evaluate the information and make an initial assessment before using the decision aid. Then participants were asked to make a final assessment after using and reading the recommendations of the decision aid. By recording the participants' initial and final assessments, as well as the decision aid's assessment, the researchers were able to create a metric for reliance on the decision aid.

Wheeler and Murthy (2011) analyze decision aid research performed previously and highlight positive and negative points about the research overall (i.e. experimental design, research question, operationalization, etc.). The researchers note that this type of experimental design, which is used in the current study (embedded control of no decision aid), is beneficial because no valuable information can be gathered from a control group of no decision aid. This within-subjects design has advantages (each participant has an

individual control) and disadvantages (potential demand effects), but should be considered in decision aid research experimental designs (Wheeler and Murthy 2011).

### **2.3.3 Development of Case**

The fraud risk assessment case study utilized was obtained from Wilks and Zimbelman (2004) and modified to capture the purpose of the current experiment. In the current study, two versions of the same case were distributed to participants, one containing relevant and irrelevant information and one with just relevant information. Refer to Appendix A for the fraud risk case distributed to participants.

An expert panel of 20 audit managers and partners (averaging 9.8 years of experience) reviewed and evaluated the case materials. The experts were randomly assigned to one of the two condition groups, totaling ten experts in each condition. The experts completed the cases on the paper version in order to validate the case, the relevant and irrelevant cues, and the overall fraud risk assessment. The experts' average fraud risk assessment served as one benchmark in the current study. There was no significant difference ( $p = .558$ ) noted in the final fraud risk assessments between the condition groups - relevant only information or relevant and irrelevant information; which also supports that the dilution effect did not occur.

The case and instruments were also pilot tested on 40 graduate level audit students. The pilot test was completed in a controlled laboratory environment, similar to the actual experiment. Each student was randomly assigned to one of the two condition groups, totaling 20 graduate students in each condition. This pilot test was completed using the expert system and served to validate the case, the instruments, and the expert system.

#### **2.3.4 Model**

The particular expert system, AudEx, used in this study captures the improvement in technology by utilizing a combination of artificial intelligence features (i.e. neural networks, fuzzy logic, etc.) in the internal design, which allows to the system to be broken into two parts. The first is the rules based mechanism, which most expert systems contain. The second is knowledge discovery, in that the system is able to discover and build models of decision making capabilities on the fly. It can be tailored so the system can be trained to recognize and utilize decision making of any one or group of individuals. This allows the system to retain data provided and work performed that the expert input, as well as rules, regulations, and procedures manually inputted into the system. With this training, the system can produce the same assessments the actual auditor would have produced as it is capable of capturing knowledge and expertise from individuals (Arnold *et al.* 2006).

Since the accounting and auditing profession is not as advanced as it could be with the successful development and use of intelligent decision aids, it was necessary to develop one that far surpassed others that currently existed (Hampton 2005). Also, the majority of studies incorporating knowledge-based systems do not use a fully functional system, so most previous research was unable to engage the user or impact the behavior of the user (Gregor 2001). Unlike the majority of previous studies designed to affect users' behaviors (Gregor 2001; Arnold *et al.* 2006), this system was designed to both capture and affect the users' behaviors, examine the use of explanations provided by the system in a decision making environment, and require users to make complex judgments.

The system can perform more efficiently and less costly in the long-run, while creating a substantially raised base line and consistent audit that can then be reviewed by

the actual auditor. This expert system is unique because it is an ultimate hybrid system. It incorporates neural networks, fuzzy logic, and algorithms all within the expert system's design. Davis *et al.* (1997) explain that the development of a prototype expert network - an integration of an expert system and a neural network - aids in the audit judgment task by allowing for efficient use of relationships among well-known control variables, and in recognizing patterns and inter-relationships among them that practicing auditors cannot express logically as a set of specific rules. For a detailed description of the internal operations of the expert system developed and used in this study refer to Appendix C: AudEx (Audit Data Assessment System).

The system includes constructive dialog, adopted from Eining *et al.* (1997). Constructive dialog creates conversation in which the participants' primary purpose is learning and understanding. Gregor and Benbasat (1999) support that novices learn from explanations provided by knowledge-based systems. Eining *et al.* (1997) use this phrase as a way to identify the features of the system that improved the decision making process and increased reliance on the decision aid. This form of dialogue makes it possible for the expert system to serve as an “electronic colleague”, which has been shown to possibly be the best opportunity for success (Arnold *et al.* 2004).

The five features of constructive dialog are as follows: judgment decomposition, prior judgment, rule presentation, reassessment opportunity, and deviation justification (Eining *et al.* 1997). Eining *et al.* (1997) show that these five features successfully influence auditor's decision-making. Judgment decomposition breaks down judgment into three components - conditions, motivations, and attitudes – and assists the auditor in combining these assessments. This step is necessary because Libby and Libby (1989)

show that human experts are successful in providing component judgments; however, the global combination of each one was more accurate when completed with a mechanical combination system. With the inclusion of constructive dialog the auditors learn and are forced to justify the rationale in developing their assessment.

The system provided explanations and rationales to the user during the interactive decision making process. This element is an essential component of knowledge-based systems used by professional decision makers and serves as a tool to increase user reliance on the system (Arnold *et al.* 2006; Mao and Benbasat 2000). According to Dowling and Leech (2007), researchers have raised concerns regarding long-term use of decision support, such as de-skilling auditors (Arnold and Sutton 1998) and lowering demand for senior and staff level auditors (Ashton and Willingham 1988). However, these are not identified as concerns by audit partners and managers.

During the experiments, the expert system presented the user with an assessment form of 16 questions relevant to assessing financial fraud risk, as per SAS 99. Although all of the SAS 99 factors are relevant to assessing the risk of fraud in a company, they were not all present in the provided case. This procedure was familiar to participants, as it incorporated aspects of the fraud risk checklist they currently utilized in practice. Participants graded each entry on what they felt was the appropriate representation of the company. At the bottom of the assessment form was an overall evaluation. This was the evaluation the participant determined based on the selections made throughout the process. This was compared to the historical results provided by the audit managers and partners whom trained the expert system.

In the present study, the system was trained by a team audit managers and partners with information specific to the case provided to participants during the experiment, as well as other random fraud risk cases. Training was based on the logic and capability of the system, and then streamlined to focus assessing fraud risk in a financial statement audit. Not all of the accounting and auditing standards, rules, and regulations were included; just those relevant to the case, which was reviewed by an expert panel of audit managers and partners for validity. Refer to section 2.3.3 Development of Case for details of the testing performed with the expert panel.

The responses provided by the audit managers and partners were used in training the system because their assessments were considered the ideal responses to the present scenario. The audit managers and partners did not experience the dilution effect as there was no significant differences ( $p = .558$ ) noted between each condition group - relevant only information or relevant and irrelevant information. There were also no significant differences between the fraud risk assessments of the experts and the other two benchmarks - Wilks and Zimbelman (2004) ( $p = .934$ ) and the expert system ( $p = .859$ ).

The responses from the expert panel of audit managers and partners were used to train the expert system. The system was also trained using other random fraud risk assessment cases obtained from various auditing textbooks. This was done in order to train the system in various fraud type scenarios and make sure that it was working properly in assessing various levels of fraud risk. To insure the system was properly trained, it was tested by asking it to determine the level of fraud risk for the different scenarios based on the information provided. There were no significant differences between the expert system's assessments and the provided solutions' assessments in the

different scenarios. Regarding the current study, the expert system's assessment had no significant differences with the expert panel ( $p = .859$ ) nor Wilks and Zimbelman (2004) ( $p = .946$ ). The system was able to build a non-linear, complex model of the decision making process and identify hidden patterns and relationships within the datasets between the different types of questions; for example, the relevance between one to another and how they all effect each other.

After training the system and then exposing and re-exposing it to a dataset, the system was able to grade and assign the fraud risk level with no significant difference from the solution's assessment. Finally it was tested by using cases it had never seen before and it appropriately assessed the level of fraud risk when compared to the solution's assessment. The system can also tell the user how all of the different questions and assessments were related to the level of fraud risk that it assessed. The system was able to rank the factors from most to least relevant in determining the level of fraud risk, so essentially some of the fraud risk factors may not even be needed in determining the risk of fraud. A validation of the expert system was performed by pilot testing the experiments on graduate level auditing students (some of which were previous audit seniors), audit managers, and audit partners.

#### **2.3.5 Dependent Variable**

The dependent variable was final judgment, which represents the auditor's final judgment on the assessed level of fraud risk.

#### **2.3.6 Manipulated Variables**

The first independent variable was use of the expert system. This was a within subjects variable with participants first making a decision without the expert system and then revising their decision after completing the case with the assistance of an expert

system. The second independent and manipulated variable was relevance (relevant only information or relevant and irrelevant information). This variable was manipulated between groups. The variable controlled for throughout all conditions was accountability. At the end of the experiment, participants were asked to provide feedback so the experimenter could determine the reason why participants did or did not experience the dilution effect.

## 2.4 Results and Discussion

Three separate benchmarks were available for overall fraud risk assessments: Wilks and Zimbleman (2004), the expert panel (audit managers and partners from the current study), and the expert system. There were no significant differences among the three separate benchmarks (Table 2).

<b>Benchmarks</b>	<b>Mean</b>
Wilks and Zimbelman	3.92
Expert Panel	3.85
Expert System	4.00

<b>Benchmark Means Compared</b>	<b><i>p-value</i><sup>*</sup></b>
Expert Panel vs. Expert System	0.859
Expert Panel vs. Wilks and Zimbelman	0.934
Expert Panel vs. Wilks and Zimbelman	0.946

\* The p-values are two-tailed.

**Table 2: Benchmark Comparisons**

Wilks and Zimbleman's (2004) results were from audit managers and senior managers from Big 4 public accounting firms with an average overall fraud risk

assessment of 3.92. The current study's expert panel of audit managers and partners', from a regional public accounting firm, overall fraud risk assessments averaged 3.85. Lastly, the expert system used in the current study determined that the overall fraud risk assessment was 4.00.

The first hypothesis, less experienced auditors will make lower fraud risk assessments when using the expert system as compared to not using the expert system, was supported by the experimental results. It was tested by comparing means of the overall fraud risk assessments of participants with and without the use of expert systems to manager and partner assessments (Table 3). The manager and partner assessments were obtained from the expert panel of auditors during testing.

**Panel A: Overall Means**

<b>Fraud Risk Assessments</b>	<b>Mean</b>	<b>Standard Deviation</b>
Expert Panel	3.85	0.813
No Expert System		
Relevant Only Information	4.26	0.915
Relevant and Irrelevant Information	4.91	0.996
Expert System		
Relevant Only Information	4.22	0.736
Relevant and Irrelevant Information	4.13	0.736

**Panel B: Relevant only information**

	<u><i>t-statistic</i></u>	<u><i>p-value</i></u> <sup>*</sup>
Relevant only information without expert system (4.26) vs. expert panel (3.85)	1.546	.130
Relevant only information with expert system (4.22) vs. expert panel (3.85)	1.556	.127

**Panel C: Relevant and irrelevant information**

Relevant and irrelevant information without expert system (4.91) vs. expert panel (3.85)	3.797	<.001
Relevant and irrelevant information with expert system (4.13) vs. expert panel (3.85)	1.033	.314

\* The p-values are two-tailed.

**Table 3: Group Comparisons to the Expert Panel**

Panel A (Table 3: Group Comparisons to  
**Table 3: Group Comparisons to the Expert Panel**

) displays the group means of overall fraud risk assessments for: (1) the expert panel ( $M=3.85$ ); (2) no expert system - relevant only information ( $M=4.26$ ) and relevant and irrelevant information ( $M=4.91$ ); and (3) use of expert system - relevant only information ( $M=4.22$ ) and relevant and irrelevant information ( $M=4.13$ ). There were no significant differences for participants in the relevant only information condition group (displayed in Panel B of Table 3), both without ( $p=.130$ ) and with ( $p=.127$ ) the use of the expert system, when compared to the expert panel. There was an overall decrease in the mean of the relevant only information condition group; however, auditors are rarely, if at all, faced with only relevant information in an audit.

There was a significant difference for participants in the relevant and irrelevant information condition group without the use of the expert system ( $p<.001$ ) when compared to the expert panel (displayed in Panel B of Table 3). However, there was no significant difference for the participants in the relevant and irrelevant information condition group with the use of the expert system ( $p=.314$ ) when compared to the expert panel (displayed in Panel B of Table 3). In the relevant and irrelevant information condition there was an overall decrease of the mean for the fraud risk assessment; which was expected due to the use of the expert system mitigating the dilution effect.

The focus for the first hypothesis is the comparison of the manager and partners to the group of participants who had relevant and irrelevant information, as this is what mirrors a realistic situation. Panel C (Table 3) shows a significant difference ( $p < .001$ ) in the overall fraud risk assessments of the managers and partners compared to the assessments made without the use of expert systems. However, when participants in this

group were able to re-assess the risk of fraud after using the expert system the overall assessments were not significantly different than that of the managers and partners ( $p=.314$ ). This finding not only supports the first hypothesis, but also supports the notion that auditors with the use of expert systems in a real world scenario (i.e. relevant and irrelevant information) are more likely to have more effective judgments and conduct more efficient audits leading to overall increased audit quality.

A within-subjects comparison was also analyzed to determine that the fraud risk assessments were lower with the use of the expert system than without the use of the expert system (Table 4). The relevant only condition group's average fraud risk assessment was lower from Time 1 (prior to using the expert system - 4.26) to Time 2 (after using the expert system - 4.22). While this was not a significant difference ( $p = .833$ ) in the average fraud risk assessment without and with the use of the expert system, it was still lower with use of the expert system. The relevant and irrelevant information condition group's average fraud risk assessment was also lower from Time 1 (prior to using the expert system - 4.91) to Time 2 (after using the expert system - 4.13). There was a significant difference ( $p = .002$ ) in the average fraud risk assessment without and with the use of the expert system, further supporting the first hypothesis.

The second hypothesis, using an expert system as a decision aid reduces the dilution effect exhibited by less experienced auditors, was also supported with the results from the experiment. This was tested by comparing the overall fraud risk assessments without the use of expert system to the overall fraud risk assessments with the use of expert system of participants with relevant and irrelevant information.

A mixed model analysis of variance with repeated measures was conducted to assess the impact of the expert system on participants' fraud risk assessments across two time periods. The descriptive statistics shown in Table 4 display the means for both groups at Time 1 (prior to using the expert system) and Time 2 (after using the expert system).

		Mean	Std. Deviation	N
<b>Time 1</b> (No Expert System/Initial Assessment)	<b>Relevant Only</b>	4.26	.915	23
	<b>Information Relevant and Irrelevant</b>	4.91	.996	23
<b>Time 2</b> (Expert System/Final Assessment)	<b>Relevant Only</b>	4.22	.736	23
	<b>Information Relevant and Irrelevant</b>	4.13	.968	23

**NOTE\*:**

*Between-subjects:*

Time 1 - The two-tailed p-value = .026, t-statistic = 2.312

Time 2 - The two-tailed p-value = .733, t-statistic = .343

*Within-subjects:*

Relevant Only Information - The two-tailed p-value = .833, t-statistic = .214

Relevant and Irrelevant Information - The two-tailed p-value = .002, t-statistic = 3.600

\*These statistics were determined using t-tests

**Table 4: Descriptive Statistics for Dilution Effect Groups**

The higher fraud risk assessments are prior to using the expert system (M=4.26 and 4.91) and they decrease after using the expert system (M=4.22 and 4.13). This change is a direct effect of using the expert system. Prior to using the expert system, the participants in the relevant and irrelevant information condition experienced the dilution effect and the fraud risk assessments were significantly higher ( $p=.026$ ) than the

assessments in the group with relevant only information. This finding is consistent with existing research (Eining and Dorr 1991; Hackenbrack 1992; Hoffman and Patton 1997; Eining *et al.* 1997; Eining and Jones 1997; Waller and Zimbelman 2003). However, after using the expert system there was no significant difference between both conditions ( $p=.733$ ) because having use of the expert system mitigated the dilution effect which was present in the relevant and irrelevant information condition prior to using the expert system<sup>6</sup>.

In looking at the interaction effect between time and expert system use, there was a statistically significant effect ( $F(1,44)=6.161$ ,  $p=.017$ )<sup>7</sup>. This suggests that there was a significant change in fraud risk assessments across the two different time periods and that the expert system had a significant effect on the dilution effect. These findings suggested that the auditors who made assessments on their own, without use of the expert system were significantly influenced by irrelevant information, unlike when auditors had use of the expert system and the dilution effect was mitigated<sup>8</sup>. Hence, the interaction statistics show that the use of the expert system has a significant effect on fraud risk assessments (Table 5). In fact, the relevant and irrelevant information condition had a final fraud risk assessment lower than (and closer to the benchmarks) the relevant only information condition after using the expert system.

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<sup>6</sup> The assumption of homogeneity of variances has not been violated ( $p=.659$ ).

<sup>7</sup> The effect size is medium to large, as defined by Cohen's guidelines, and each of the differences is significant.

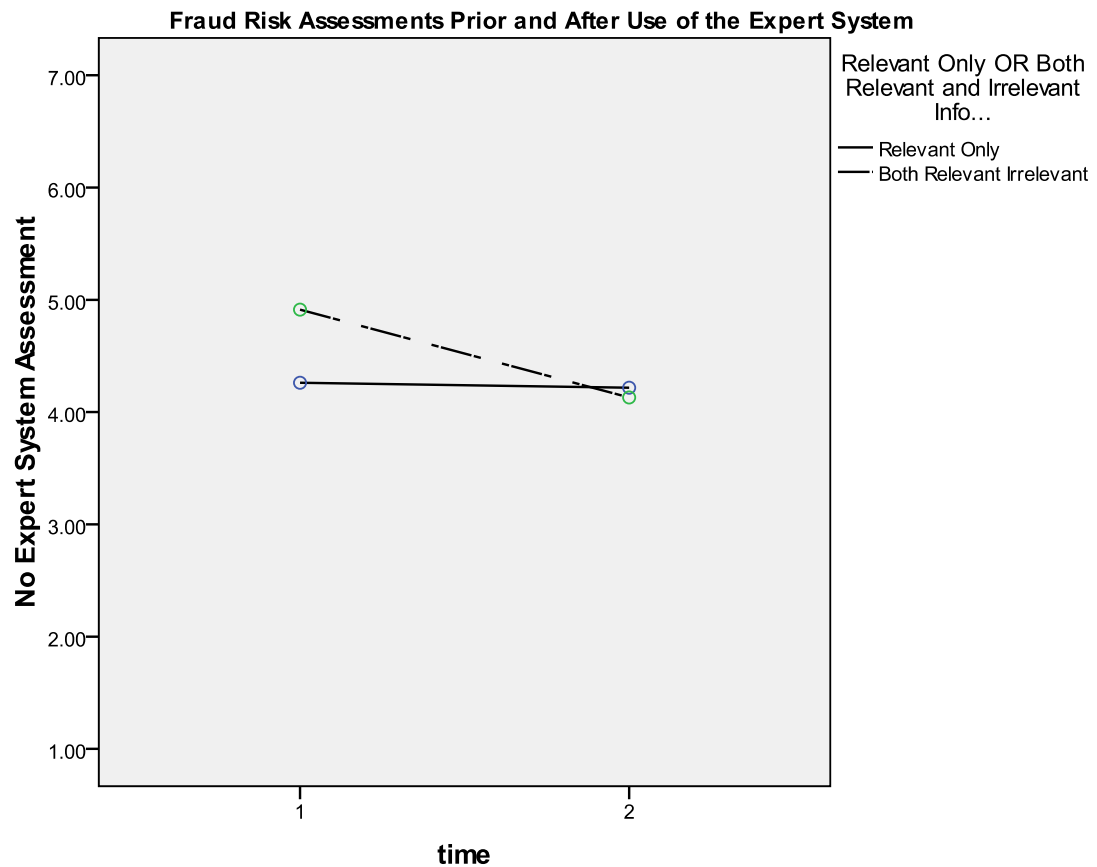
<sup>8</sup> The mixed model analysis of variance was also run with three covariates - years of experience, task experience (making fraud risk assessments), and confidence in fraud risk assessment - and results were quantitatively similar independently and collectively (years of experience:  $p = .012$ ; task experience:  $p = .036$ ; confidence:  $p = .014$ ; all covariates:  $p = .025$ ).

<u>Effect</u>	<u>Test</u>	<u>Value</u>	<u>F</u>	<u>Hypothesis</u> <u>df</u>	<u>Error</u> <u>df</u>	<u>Sig.*</u>	<u>Partial</u> <u>Eta</u> <u>Squared</u>
Time	Wilks'						
	Lambda	0.851	7.696	1	44	0.008	0.149
Time*Group	Wilks'						
	Lambda	0.877	6.161	1	44	0.017	0.123

\*All p-values are two-tailed.

**Table 5: Mixed Analysis of Variance with Repeated Measures: Within-Subjects Testing for Dilution Effect**

The interaction effect is also shown in the plot (Table 6). The plot also supports that prior to using the expert system, the fraud risk assessments were significantly higher in the relevant and irrelevant information condition than in the relevant only information condition; however, after using the expert system the fraud risk assessments were not significantly different.



**Table 6: Mixed Analysis of Variance with Repeated Measures: Within-Subjects Testing (Interaction) for Dilution Effect**

The main effect (Table 5) displays a statistically significant effect for time as well ( $F(1,44)=7.696, p=.008$ )<sup>9</sup>. This suggests that there was a change in fraud risk assessments across the two different time periods, prior to and after using the expert system.

<sup>9</sup>The effect size is large, as defined by Cohen's guidelines, and each of the differences is significant.

The between-subjects test (Table 7) indicates that there was no significant difference ( $p=.212$ ) between the two conditions for the final fraud risk assessment (after using the expert system)<sup>10</sup>.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.*	Partial Eta Squared
Intercept	176.315	1	1765.315	1542.750	< 0.001	0.972
Group	1.837	1	1.837	1.605	0.212	0.035
Error	50.348	44	1.144			

\*All p-values are two-tailed.

**Table 7: Mixed Analysis of Variance with Repeated Measures: Between-Subjects Testing for Dilution Effect**

The results show that use of the expert system mitigated the dilution effect in the condition with relevant and irrelevant information and the final assessment was not significantly different from the condition with relevant only information<sup>11</sup>.

In addition, a detailed analysis of the fraud risk factors considered (prior and during use of expert system) by participants in making initial and final fraud risk assessments.<sup>12</sup> This type of analysis looking at specific factors has not been demonstrated in prior audit literature to further support the dilution effect occurring. General conclusions were made stating that the effect occurred; however a closer look into the specifics of the effect occurring were not evidenced (Shelton 1999; Glover 1997; Hoffman and Patton 1997).

<sup>10</sup> The effect size is very small (.035); therefore, it is not surprising that it did not reach statistical significance.

<sup>11</sup> The mixed model analysis of variance was also run with three covariates - years of experience, task experience (making fraud risk assessments), and confidence in fraud risk assessment - and results were quantitatively similar independently and collectively (years of experience:  $p = .194$ ; task experience:  $p = .105$ ; level of confidence:  $p = .263$ ; all covariates:  $p = .052$ ).

<sup>12</sup> Fraud risk factors were assessed on a 7-point likert scale (1=extremely unimportant and 7=extremely important).

This additional analysis was also performed to determine if any other effects were noted (i.e. anchoring, fraud triangle-any factor of more focus, etc.) between participant condition groups (relevant only information or relevant and irrelevant Information ) and each condition group verses the expert panel of audit partners and managers. While findings did not demonstrate other effects or characteristics occurring, they do further support that irrelevant information is the driving effect in the dilution effect occurring among audit seniors.

The untabulated results from comparison of the means (t-tests) show no significant differences in the means of the relevant information and significant differences in the means of irrelevant information. In fact, between the two participant condition groups there was almost no difference at all in the assessments of the relevant information; therefore, the difference between initial fraud risk factors was due to the relevant and irrelevant information condition group factoring in the irrelevant information into the initial fraud risk assessments (the dilution effect).

Both condition groups were under weighing relevant factors when compared to the expert panel group; however, both condition groups still had an increased overall fraud risk assessment. The three most underweighted factors (in order from most to least underweighted) related to global operations of the company, the company having marginal ability to meet debt repayment requirements, and high degree of competition or market saturation accompanied by declining margins. Further research into these results is needed and Chapter 4 attempts to elaborate on them via a protocol analysis.

## **2.5 Conclusions**

This study aimed to examine and reduce to the dilution effect problem, which occurred in less experienced auditors' assessment making process. A laboratory

experiment was conducted to examine the influence of the use of the expert system on the assessment and evaluation of fraud risk by less experienced auditors. The dilution effect judgment bias was tested by employing a 2 (x 2) design.

The first proposed hypothesis stated that less experienced auditors will make lower fraud risk assessments when using the expert system as compared to not using the expert system. Results of the experiment supported that the less experienced auditors in the condition group who had use of the expert system assessment did produce an overall fraud risk assessment lower than without using the expert system, and it was closer to the expert panel's fraud risk assessments (the benchmark), with no significant variances.

The second hypothesis suggested that using an expert system as a decision aid reduces the dilution effect exhibited by less experienced auditors. Results also supported this hypothesis. Assessments initially made by participants in the relevant and irrelevant information condition group before the use of the expert system did display the dilution effect. This effect was subsequently reduced after participants used the expert system to make a final assessment. Based on the overall results of the study, an expert system could serve as a reliable and effective decision aid for auditors' in making assessments.

If awareness of expert systems is wide-spread among auditors, expert systems could be used as decision aids by auditors. Also, if accounting firms were properly informed and trained on expert systems and the value of utilizing them as a decision aid, more appropriate assessments could be made and potential for reduced time and cost savings could be presented. If auditors were to spend less time employing their judgment in evaluating and assessing initial data, they could spend more time in performing

procedures, employing judgment in other significant areas of the audit, and focusing on the business environment of the client.

Future research can examine the impact of the expert system as decision aids on International Financial Reporting Standards, since the transition will be made from rules-based accounting to principles-based accounting. Also, research can be done to determine if an over-reliance on the expert system develops. Specifically, if there are factors an expert system cannot account for will auditors still rely on them. Researchers can also examine the different decision making heuristics used by experienced versus novice auditors in environments where judgment biases exist. If a clean template of decision making without bias (via audit managers) can be created a comparison can be done between auditor levels, and ultimately a better understanding can be obtained of judgment biases.

## **Chapter 3: Using an Expert System to Debias the Acceptability Heuristic in Auditor Judgment**

### **3.1 Introduction**

Previous researchers have related the use of expert systems as decision aids by auditors to be utilized in making better assessments related to the client (Gal and Steinbart 1987; Borthick and West 1987; Eining and Jones 1997). This finding has yet to be applied in reducing the acceptability heuristic bias, which predominantly occurs and is exacerbated in auditors when they are knowingly held accountable. Prior studies have shown that less experienced who are aware of the views of audit partners, will align their judgments to agree with that of the partners'. This negative behavioral effect, in relation to auditors' judgments, has been an area researchers have vastly studied (Gibbins and Newton 1994; Koonce *et al.* 1995; Peecher 1996; Peytcheva and Gillett 2011), yet a method to reduce it has yet to be offered.

The purpose of this study is to experimentally examine whether the use of an expert system as a decision aid will mitigate auditor judgment alignment behavior with incorrect partner influence. This study responds to calls for research to investigate whether an expert system will mitigate the acceptability heuristic (e.g., Hoffman and Patton 1997; Peytcheva and Gillett 2011). For example, Peytcheva and Gillett (2011) suggest that the use of a decision aid may reduce the bias caused by auditors aligning their judgments with that of audit partners'.

More specifically, the use of an expert system (AudEx), adapted from Chapter 2, is examined in the context of audit seniors making fraud risk assessments in an environment where the acceptability heuristic bias is present. It includes constructive dialog, adopted from Eining *et al.* (1997). Constructive dialog creates conversation in

which the participants' primary purpose is learning and understanding. Eining *et al.* (1997) use this phrase as a way to identify the features of the system that improved the decision making process and increased reliance on the decision aid.

The present study focuses on less experienced auditors because the overwhelming consensus is that this judgment alignment behavior occurs in less experienced auditors when knowingly held accountable to superiors (Gibbins and Newton 1994; Koonce *et al.* 1995; Peecher 1996; Peytcheva and Gillett 2011). This particular auditor level is also important to examine as they are responsible for the majority of audit field work.

If a knowledge-based expert system is utilized in auditor judgment and decision making, the judgment alignment behavior may be reduced. The use of a decision aid would prompt auditors to focus attention on the relevant information and force them to document and justify their assessments. An expert system was chosen as the decision aid because previous researchers have suggested that expert systems have a high level of accuracy (Bell *et al.* 1993) and using an expert system as a decision aid will increase the appropriateness of the judgments made by less experienced auditors (Libby and Libby 1989; Gal and Steinbart 1987).

A laboratory experiment was conducted to examine the influence of the use of the expert system on the assessment and evaluation of management fraud in reducing the acceptability heuristic bias. A 2 (x 2) design was employed. The use of the expert system (no expert system or expert system) was manipulated between groups. Learning partners' views was a within subjects variable with participants first making a decision without learning the partners' views and then revising their decision after learning the

partners' views. All participants were knowingly held accountable in their assessments and had to justify the evaluations.

This study contributes to the literature by demonstrating that the use of an expert system as a decision aid by audit seniors making fraud risk assessments can reduce this judgment alignment behavior. Although prior researchers have examined this effect in relation to auditors' judgments, the use of expert systems to reduce the acceptability heuristic has yet to be applied (Gibbins and Newton 1994; Koonce *et al.* 1995; Peecher 1996; Peytcheva and Gillett 2011). This study also contributes to the research on fraud risk assessments which has demonstrated that auditors find it difficult to assess the likelihood of management fraud. Auditors' risk assessments are important because "too weak a response could jeopardize the effectiveness of the audit (i.e. could fail to uncover existing fraud) and too strong a response could result in an inefficient audit" (Eining *et al.* 1997).

The next section presents the theory and the hypotheses developed. The third section describes the methodology and research design. The fourth section explains results and the last section contains the conclusions.

### **3.2 Theoretical Background and Hypotheses Development**

#### **3.2.1 Biases in Auditor Judgment Exacerbated by Accountability**

One negative behavior exhibited by auditors exacerbated by, not mitigated by, accountability is the acceptability heuristic bias - auditor judgment alignment behavior - which is the focus of the present study. While this negative bias occurs regardless of accountability, previous studies have shown that this negative behavior predominately occurs when less experienced auditors are knowingly held accountable to superiors (Gibbins and Newton 1994; Koonce *et al.* 1995; Peecher 1996; Peytcheva and Gillett

2011). For a complete description of auditor biases and the effects of accountability refer to \*Audit study

Table 1.

Prior literature has shown that auditors who were held accountable to their superiors had a systematic tendency to give inaccurate judgments, for reasons such as, lack of confidence, experience, and knowledge (Hoffman and Patton 1997; Buchman *et al.* 1994), leading to over auditing and overly conservative assessments (Messier Jr. and Quilliam 1992; Hackenbrack 1992; Morton and Fleix 1991; Lord 1992; Buchman *et al.* 1994; Quilliam 1993; Hoffman and Patton 1997; Shelton 1999). Further, auditors exhibit different assessments when held accountable versus not held accountable (Johnson and Kaplan 1991; Lord 1992; Kennedy 1993).

Other previous studies suggest when auditors make decisions their process and decisions are influenced by accountability to superiors and, if known, the superiors' views influence their decision (Johnson and Kaplan 1991; Koonce *et al.* 1995). Research suggests auditors may be different types of decision makers in different environments (Payne 1982). Other prior audit studies' findings support the predictions of the social contingency model regarding accountability (Tetlock and Boettger 1989; Tetlock 1983 and 1985a). The social contingency model assumes that when ambiguity surrounds a difficult decision, the decision maker is influenced by the view of the superior whom holds that person accountable (Buchman *et al.* 1994).

Accountability causes certain pressures on auditors to fit into a self-perceived expectation, which leads to negative behavioral effects (Buchman *et al.* 1994; Gibbins and Newton 1994; Tan *et al.* 1997). Auditors desire approval from superiors (Tetlock

1983; Tetlock *et al.* 1989) and that desire is the motivation behind their seeking minimize the cognitive effort used while maintaining a position that is socially acceptable (Tan *et al.* 1997; Gibbins and Newton 1994).

### **3.2.2 Auditor Acceptability Heuristic: Judgment Alignment Behavior**

Although accountability does not always result in a negative effect (Kennedy 1993; Messier and Quilliam 1992), its mere presence has the capability to bias decision-makers to align with the views of the evaluative audience (Tetlock 1983). Research demonstrates that auditors' judgment is influenced when they are made aware the audit partners' views before and after making their own assessments (Peecher 1996; Tan *et al.* 1997; Cohen and Trompeter 1998; Turner 2001; Wilks 2002; Peytcheva and Gillett 2011). This is otherwise known as the acceptability heuristic. Buchman *et al.* (1994) and Tan *et al.* (1997) demonstrate that on average, auditors knowingly held accountable are influenced by partners' views when exposed to those views.

The acceptability heuristic is a more difficult bias than others to overcome because once auditors know the views of the very superiors they are accountable to certain demand effects occur within the auditor (i.e. aiming to please, personal incentives, avoiding convincing the partner why his view is inaccurate). For example, Buchman *et al.* (1994) suggest that once individuals learn the views of their evaluators they employ less of a complex cognitive process and more of an acceptability heuristic to overcome these demand effects. The theory of cognitive dissonance supports auditors having two opposing cognitions after they learn the views of partners'. They are one's own independent judgment and one's advantage in reporting their superiors' judgment (Tetlock 1985a; Peytcheva and Gillett 2011).

Social psychology literature suggests that individuals, who are held accountable for their actions and decisions, are affected by how they process information and make decisions (Tetlock 1983; Beach and Mitchell 1978; Tetlock *et al.* 1989). For example, auditors in a public accounting setting have a need for approval from their superior, which causes an alignment with the preference of that superior to whom they are held accountable (Gibbins and Newton 1994; Koonce *et al.* 1995; Peecher 1996).

Audit firms have a mentoring system in place which supports this alignment behavior found in less experienced auditors. Dirsmith and Covalenski (1985) find that mentors teach their mentees “partner-like” behavior as a way to gain promotions. This leads accountable auditors to adopt the acceptability heuristic (Buchman *et al.* 1994) as a way to please superiors and increase chances of promotion. The social context and audit philosophy in audit firms have a substantial influence on auditor judgments (Carpenter *et al.* 1994), which supports auditors needing social approval as opposed to expending more cognitive effort (Tan *et al.* 1997).

**H1:** Less experienced auditors who learn partners’ views after they have made a judgment themselves alter their original judgment, aligning it with partners’ views.

Peytcheva and Gillett (2011) assert that the use of a decision aid reduces the bias caused by auditors aligning their judgments with that of audit partners’ – behavior resulting from the acceptability heuristic. This may be because individual’s memories of their judgment may be weak once formed; leading them to abandon their own judgment once they are aware of superiors’ views (Peytcheva and Gillett 2011). For instance, subsequent events retroactively influence memory, which can bias and create false memories (Loftus and Pickrell 1995). Peytcheva and Gillett (2011) suggest reducing this

bias through documentation procedures, which can be done more precisely with the use of a decision aid.

### **3.2.3 Expert Systems as Decision Aids**

As discussed in detail in Chapter 2, numerous studies have been done regarding auditor's use of decision aids and expert systems are the decision aid of choice (Anderson *et al.* 1995, 2003; Bedard and Graham 2002; Boatsman *et al.* 1997; Dowling and Leech 2007; Seow 2011); which is why an expert system was the decision aid of choice in the current study. For a more detailed discussion on the previous literature regarding expert systems refer to Chapter 2.

Decision aids that make the knowledge and expertise of partners and managers available to all auditors in the firm have the potential of improving auditor judgments of management fraud risk (Hackenbrack 1993; Eining *et al.* 1997; Gillett and Uddin 2005). Expert systems in particular have been shown to improve auditor decision making regarding fraud risk assessments (Eining and Jones 1997); which is the rationale for the current study using a fraud risk scenario case.

Using an expert system as a decision aid can mitigate auditor acceptability heuristic bias exacerbated in auditors because expert systems serve as learning tools, take the auditor interactively and methodically through the decision making process, force the auditor to justify one's assessment, and provides a means of support to the auditor upon developing one's final judgment (Gal and Steinbart 1987; Mauldin 2003; Peytcheva and Gillett 2011).

**H2:** Using an expert system as a decision aid reduces the acceptability heuristic bias experienced by less experienced auditors.

Although expert systems as decision aids have been demonstrated to successfully assist auditors in developing assessments, some level of reliance on and feasibility of the decision aid by the user is needed to achieve success (Arnold *et al.* 2004). A detailed discussion on reliance of decision aids is presented in Chapter 2; however, it should be noted that the current study employed a complex task of developing a fraud risk assessment based on previous studies supporting that reliance increases with task complexity (Ashton 1990; Arnold and Sutton 1998; Brown and Jones 1998; Hunton *et al.* 2010). Technology dominance, another issue with expert systems, is addressed by the expert system used in the current study because the system forces the auditor to analyze and justify decisions made. This avoids the decision aid taking primary control of the user in making the decision because the user must provide rationale to justify his final decision.

### **3.3 Methodology and Research Design**

#### **3.3.1 Participants**

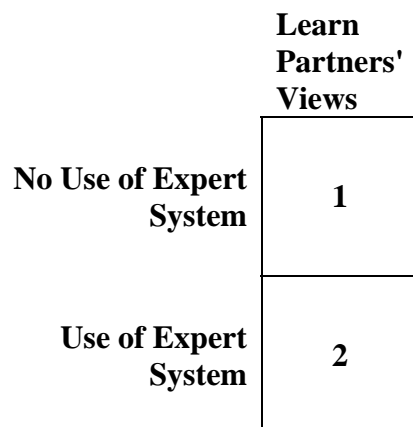
Audit seniors from a regional public accounting firm were selected as participants because prior research has shown this judgment alignment behavior occurs with less experienced auditors (Peytcheva and Gillett 2011). There were 44 participants averaging 4.09 years of experience, were all involved in making fraud risk assessments (averaging 8.77 fraud risk assessments made in the last three years), and familiar with SAS 99 and the checklist that supports it. This was obtained by participants completing a post-experimental questionnaire. All participants were told they were held accountable for their assessments and had to justify the final judgments by providing explanations and support for their assessment; regardless if the assessment had been revised from the initial assessment. Participants were prompted to input their names as part of the user

log-in to insure accountability was employed consistent with previous studies (Peecher 1996; Lord 1992; Peytcheva and Gillett 2011).

Participants were randomly split into two condition groups, no use of expert system or use of expert system, each responsible for making a fraud risk assessment on the provided case. For credibility purposes, participants were told that the firm had already implemented this expert system and wanted to obtain feedback from employees. Participants inputted all data into computers, so all information was stored electronically.

### **3.3.2 Experimental Design**

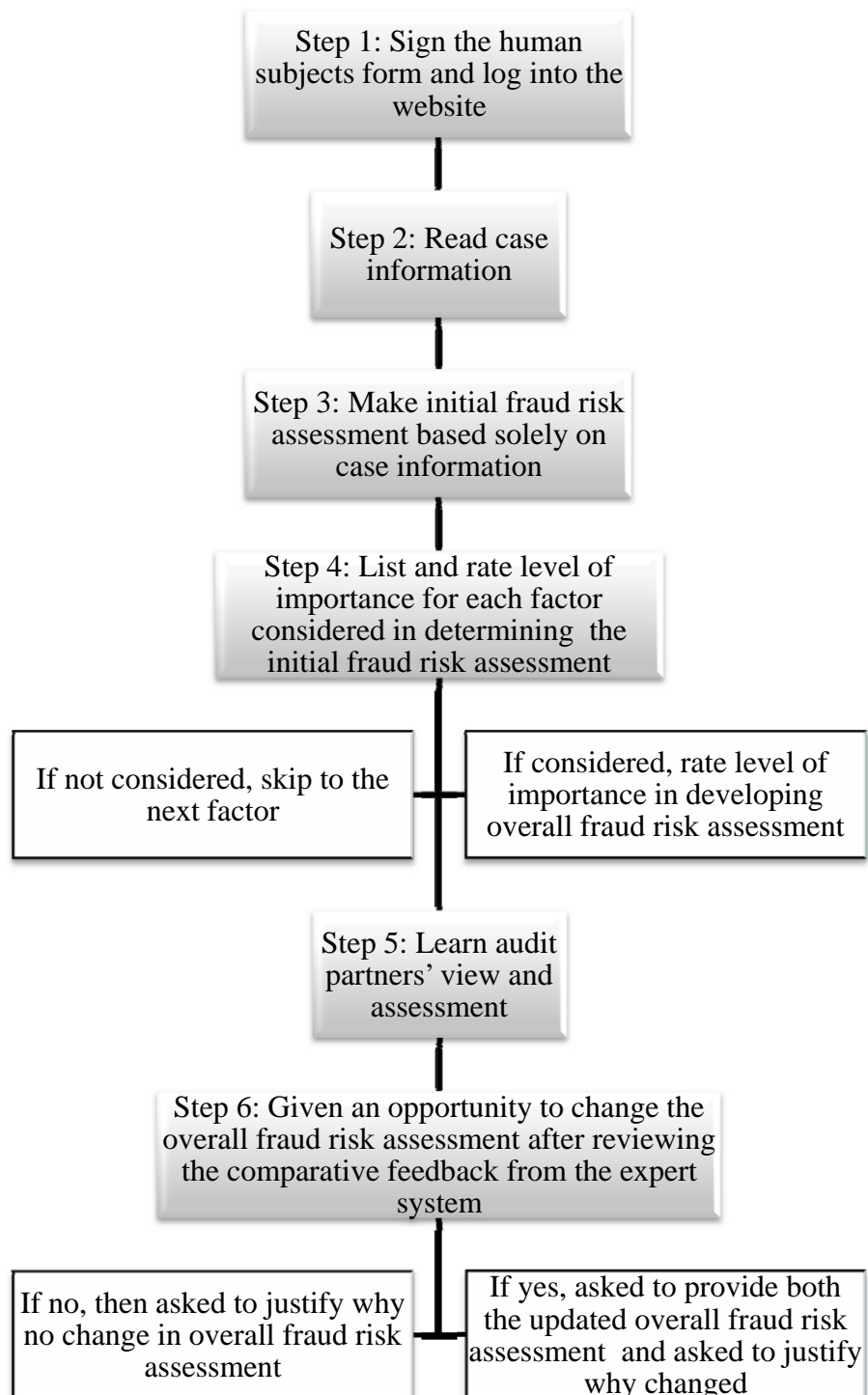
A laboratory experiment was conducted to examine the influence of the use of the expert system as a decision aid on the assessment and evaluation of fraud risk in an environment with the acceptability heuristic bias present (Figure 3). This experiment was conducted at the home offices of participants in a controlled laboratory environment and employed a 2 (x 2) repeated measure design. The use of the expert system (no use of expert system or use of expert system) was manipulated between groups. Learning partners' views was a within-subjects variable with participants first making a decision without learning partners' views and then revising their assessment after learning partners' views.



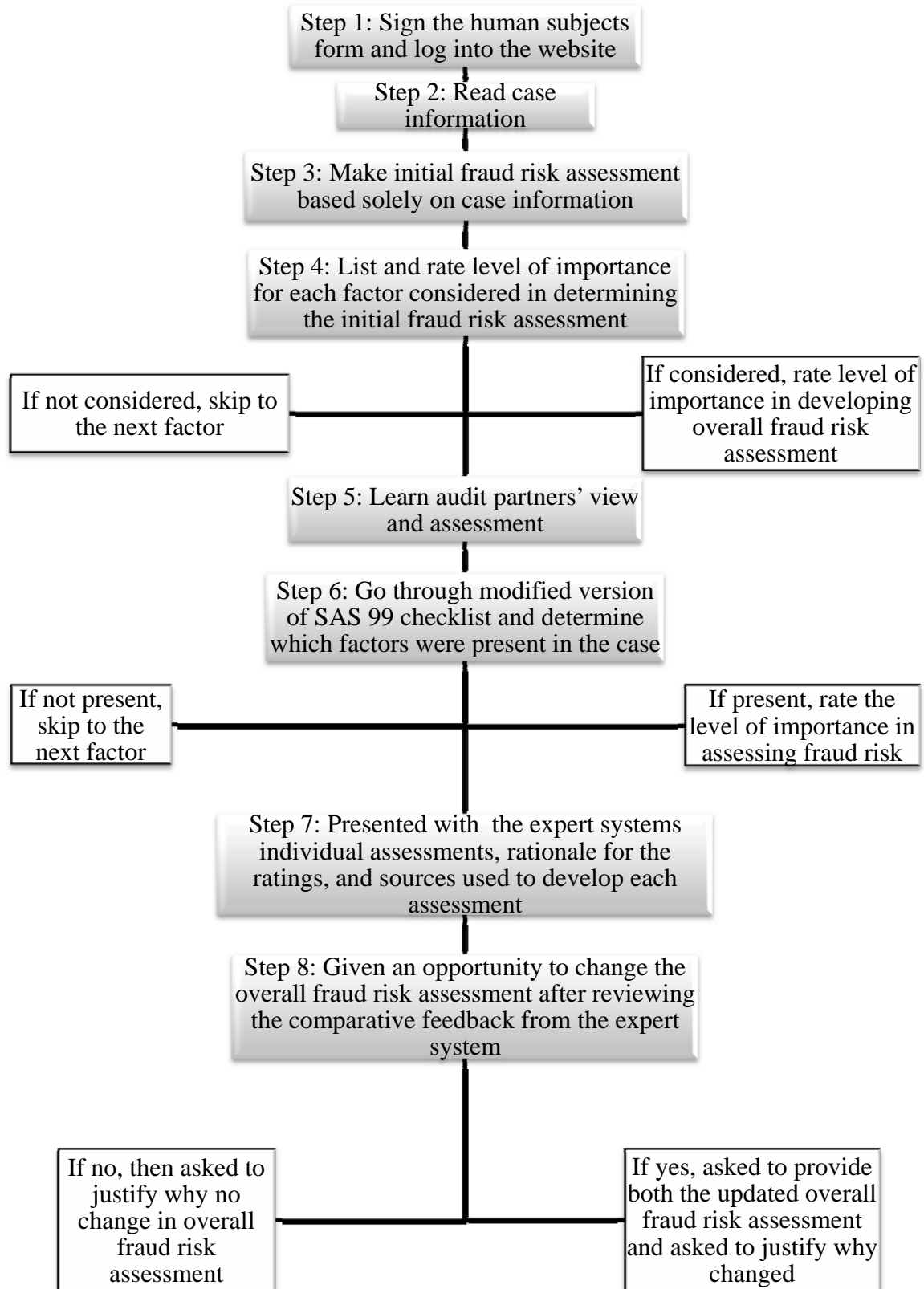
No Use of Expert System		Use of Expert System
<b>Part One</b>	Case evidence	Case evidence
	Make initial judgment	Make initial judgment
<b>Part Two</b>	Learn partners' views	Learn partners' views
		Use expert system in developing final judgment
	Submit final judgment	Submit final judgment
<b>1</b>		<b>2</b>

**Figure 3: Acceptability Heuristic: Experimental Design**

The experimental design was developed to mimic the process of assessing fraud risk on an actual audit, so the participants were able to relate to the steps in the process during the experiment (Figure 4).

**Group One: No Use of Expert System**

### Group Two: Use of Expert System



**Figure 4: Flow of the Experiment - Acceptability Heuristic**

In part one of both conditions, all participants received the same case information. After reading the case information the subjects then made and inputted an initial judgment on the overall fraud risk. After making an initial fraud risk assessment the participants rated the factors that contributed to that assessment. This part of the experiment was done without use of the expert system and before learning partners' views.

In part two of the experiment participants all learned the audit partners' views and respective fraud risk assessment of the company presented in the case. All of the audit partners' views stated that the fraud risk should be assessed at "Very High - 6", which was the incorrect response. The partners' response was followed by rationales to justify the assessment. Rationales were included to give the partners' views more credibility.

Participants who did not have use of the expert system were then given an opportunity to change the initial assessment for overall fraud risk and then had to justify why the assessment was or was not changed from the initial assessment.

Participants who had use of the expert system were then taken through a series of questions, in line with the SAS 99 fraud indicators (all participants were greatly familiar with SAS 99 and the fraud risk factors), containing cues relevant to indicating fraud, but only some were present in the specific case. That was followed by the expert system taking participants through a comparison of participants' and expert system's assessments of each fraud risk indicator, with the expert system stating rationales and sources (i.e. SAS 99) used to assess each indicator.

Lastly, the system asked if they would like to change their initial fraud risk assessment. The system did not provide an overall fraud risk assessment as to avoid the

acceptability heuristic occurring with the participants due to learning the expert system's assessment. Also, since participants were not told the appropriate fraud risk assessment by the expert system, it is suggested that the participants revised their fraud risk assessment due to the process of using the expert system and learning from using the system.

Ultimately, the overall fraud risk assessment needed to be justified by the participants providing an explanation to support the final fraud risk assessment, regardless if the initial fraud risk assessment was revised by the participants. At the end of the experiment, participants were shown the expert system's overall fraud risk assessment compared to their own; however, participants were not able to make any changes. Lastly, participants in both condition groups were asked to provide feedback and demographical information via a post experiment questionnaire. The experimental design was set-up this way in order to mimic the real-life process of making fraud risk assessments on an audit, so the participants were able to relate to the steps in the process during the experiment.

### **3.3.3 Development of the Case**

The original case was obtained from Wilks and Zimbleman (2004). The fraud risk assessment case was modified and used in Chapter 2 and then was slightly modified again for the current study. The task required participants to assess the overall risk of fraud for a fictitious company. Each participant was given an identical scenario, regardless of which group they were assigned. Refer to Appendix B for the scenario distributed to participants.

Previous studies, relating to accountability and auditor judgment, involve ambiguous areas, such as going concern judgments (Wilks 2002), practice

development issues (Cohen and Trompeter 1998) and preliminary analytical review tasks (Tan *et al.* 1997). This current experiment also focused on an ambiguous task requiring judgment to commensurate with the experience level of audit seniors. An expert panel of 20 audit managers and partners (averaging 9.8 years of experience) validated the case and overall fraud risk assessment. For details of the expert panel's testing refer to Chapter 2 (section 2.3.3 Development of Case).

The experiment was pilot tested on 40 graduate level audit students. The pilot test was completed in a controlled laboratory environment, similar to the actual experiment. Each student was randomly assigned to one of the two condition groups, totaling 20 graduate students in each condition. The pilot test served to validate the case, the instruments, and the expert system. For details of the pilot refer to Chapter 2 (section 2.3.3 Development of Case).

### **3.3.4 Model**

The expert system used in the current study, AudEx, was the same system used in Chapter 2 and was trained by an expert panel of audit partners and managers, so less experienced auditors using this system can learn and be trained from it as if it was the actual partner or manager on the job. AudEx can be used as a decision aid specific for the audit industry. For a detailed description and assessment of the expert system used in this study refer to Appendix C: AudEx (Audit Data Assessment System) and Chapter 2 (2.3.4 Model). AudEx is capable of capturing continual advances in technology with its combination of artificial intelligence features (i.e. neural networks, fuzzy logic, algorithms, etc.) in its internal design; which also make the system a unique hybrid system. It has the rules based mechanism of a traditional expert system, knowledge discovery capability of a neural network, and constructive dialog to allow users to learn.

The system was trained with the specific fraud risk case used in this study, as well as other random fraud risk cases. Training was based on the logic and capability of the system, and then streamlined to focus assessing fraud risk in a financial statement audit. The audit managers and partners did not experience the acceptability heuristic bias as there was no significant differences ( $p = .558$ ) noted between each condition group - no use of expert system or use of expert system. There were also no significant differences between the fraud risk assessments of the experts and the other two benchmarks - Wilks and Zimbelman (2004) ( $p = .934$ ) and the expert system ( $p = .859$ ).

### **3.3.5 Dependent Variable**

The dependent variable was final judgment, which represented the auditor's final overall fraud risk assessment. In part two of the experiment participants were asked to submit their final judgment.

### **3.3.6 Manipulated Variables**

The first independent variable was learning partners' views. This was a within subjects variable with participants first making an assessment without learning partners' views and then revising their decision after learning partners' views. Although all participants learned audit partners' views, they did not learn them until after making an initial fraud risk assessment. The second independent and manipulated variable was use of the expert system (no use of expert system or use of expert system). This variable was manipulated between groups. The variable controlled for throughout both groups was accountability.

The effectiveness of the manipulation in the experiment was assessed during the post-experiment questionnaire. All participants were given the same questionnaire which included the following manipulation check question:

1) Did you learn the partners' assessment of fraud risk?

\_\_\_\_No    \_\_\_\_Yes

If yes, what was the partners' assessment of the fraud risk?

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

Also at the end of the experiment, both groups were asked to provide feedback so the experimenter could determine the reason why participants did or did not change their final judgments.

### 3.4 Results and Discussion

#### 3.4.1 Manipulation Check

All 44 participants passed the manipulation check and their responses were included in the analysis. They all responded that they did learn the audit partners' assessment and the assessment was six, very high. This was the correct response to the embedded manipulation of learning the audit partners' view.

#### 3.4.2 Hypotheses Tests

Overall fraud risk assessments were compared to three separate benchmarks:

Wilks and Zimbleman (2004), the expert panel (from Chapter 2), and the expert system.

No significant differences were noted among any of the benchmarks (

Table 8).

<b>Benchmarks</b>	<b>Mean</b>
Wilks and Zimbelman (2004)	3.92
Expert Panel	3.85
Expert System	4.00
<b>Benchmark Means Compared</b>	<b><i>p-value*</i></b>
Expert Panel vs. Expert System	0.859
Expert Panel vs. Wilks and Zimbelman	0.934
Expert System vs. Wilks and Zimbelman	0.946

\* The p-values are two-tailed.

#### **Table 8: Benchmark Comparisons**

Wilks and Zimbleman's (2004) results were from audit managers and senior managers from a Big 4 public accounting firm with an average overall fraud risk assessment of 3.92 in the study. The expert panel's results were from audit managers and partners in a regional public accounting firm with an overall fraud risk assessment of 3.85. Lastly, the expert system used in the current study determined that the overall fraud risk assessment was 4.0.

The first hypothesis suggested less experienced auditors who learn partners' views after they have made a judgment themselves alter their original judgment, aligning it with partners' views. Results support this hypothesis (Table 9). First, the mean from the expert panel was compared to the fraud risk assessments from both groups, without and with the use of the expert system.

**Panel A: Overall Means**

<b><u>Fraud Risk Assessments</u></b>	<b><u>Mean</u></b>	<b><u>Standard Deviation</u></b>
Expert Panel	3.85	.813
No Expert System		
Initial Assessment	4.09	.811
Final Assessment	5.27	.631
Expert System		
Initial Assessment	4.18	1.090
Final Assessment	4.31	.839

**Panel B: No Expert System**

	<b><u>t-statistic</u></b>	<b><u>p-value*</u></b>
Initial assessment (4.09) vs. Expert Panel (3.85)	.960	.343
Final assessment (5.27) vs. Expert Panel (3.85)	6.369	<.001

**Panel C: Expert System**

Initial assessment (4.18) vs. Expert Panel (3.85)	1.104	.276
Final assessment (4.31) vs. Expert Panel (3.85)	1.834	.074

\* The p-values are two-tailed.

**Table 9: Group Comparisons to the Expert Panel**

Panel A (Table 9) displays the group means of overall fraud risk assessments for: (1) expert panel - audit managers and partners (M=3.85); (2) no use of expert system - initial fraud risk assessment (M=4.09) and final fraud risk assessment (M=5.27); (3) use of expert system - initial fraud risk assessment (M=4.18) and final fraud risk assessment (M=4.31). In the no use of expert system condition group displayed in Panel B (Table 9) there is no significant difference between the means of the initial fraud risk assessment and expert panel (p=.343); however, there is a significant difference between the means

of the final fraud risk assessment and expert panel ( $p < .001$ ). Also, the mean of the final fraud risk assessment for the no expert system group is not statistically different than the audit partners' view ( $M=6$ ,  $p=.272$ ) - the inappropriate fraud risk assessment. In use of the expert system condition group shown in Panel C (Table 9) there is no significant difference between both the initial fraud risk assessment and expert panel ( $p=.276$ ) and the final fraud risk assessment and expert panel ( $p=.074$ ). These results support the first hypothesis.

A mixed model analysis of variance was conducted to assess the impact of the expert system on participants' fraud risk assessments across two time periods. The descriptive statistics shown in Table 10 display the means for both groups at Time 1 (before learning partners' views) and Time 2 (after learning partners' views).

		Mean	Std. Deviation	N
<b>Time 1</b> <b>(Before Learning</b> <b>Partners'</b> <b>Views/Initial</b> <b>Assessment)</b>	<b>No Expert</b> <b>System</b>	4.09	0.811	22
	<b>Expert</b> <b>System</b>	4.18	1.097	22
<b>Time 2</b> <b>(After Learning</b> <b>Partners' Views/Final</b> <b>Assessment)</b>	<b>No Expert</b> <b>System</b>	5.27	0.631	22
	<b>Expert</b> <b>System</b>	4.32	0.839	22

*NOTE\*:*

Between-subjects:

Time 1 - The two-tailed p-value = .756, t-statistic = .313

Time 2 - The two-tailed p-value < .001, t-statistic = 4.266

Within-subjects:

No expert system - The two-tailed p-value < .001, t-statistic = 5.786

Expert System - The two-tailed p-value = .623, t-statistic = .498

\*These statistics were determined using t-tests

**Table 10: Descriptive Statistics for Acceptability Heuristic Groups**

The results in Table 10 support the first hypothesis by showing that there is no significant difference ( $p=.756$ ) in the means between conditions before learning partners' views; however, there is a significant variation ( $p<.001$ ) in the means between conditions after learning partners' views. This finding is consistent with existing research (Peytcheva and Gillett 2011). The results further support the first hypothesis by displaying no significant difference within the condition of expert system ( $p=.623$ ); while there is a significant variation within the no expert system condition ( $p<.001$ ). The analysis in Table 10 demonstrated that auditors' overall fraud risk assessments with the use of the expert system did produce a less biased outcome ( $M=4.31$ ), even after learning audit partners' views. This result was in-line with the expert panel benchmark ( $M=3.85$ ), as there was no significant variation in the means ( $p=.074$ ).

In looking at the interaction effect between time and learning partners' views in the condition without use of the expert system (Table 11), there was a statistically significant effect ( $F(1,42)=9.375$ ,  $p=.004$ )<sup>13</sup>. This suggests that there was a significant change in fraud risk assessments across the two different time periods and learning partners' views had a significant effect on audit seniors' fraud risk assessments. These findings suggest that the auditors who made assessments on their own, without use of the expert system, were significantly influenced by learning partners' views (acceptability heuristic)<sup>14</sup>.

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<sup>13</sup> The effect size is medium to large, as defined by Cohen's guidelines, and each of the differences is significant.

<sup>14</sup> The mixed model analysis of variance was also run with three covariates - years of experience, task experience (making fraud risk assessments), and confidence in fraud risk assessment - and results were quantitatively similar independently and collectively (years of experience:  $p = .013$ ; task experience:  $p = .011$ ; confidence:  $p = .013$ ; all three:  $p = .024$ ).

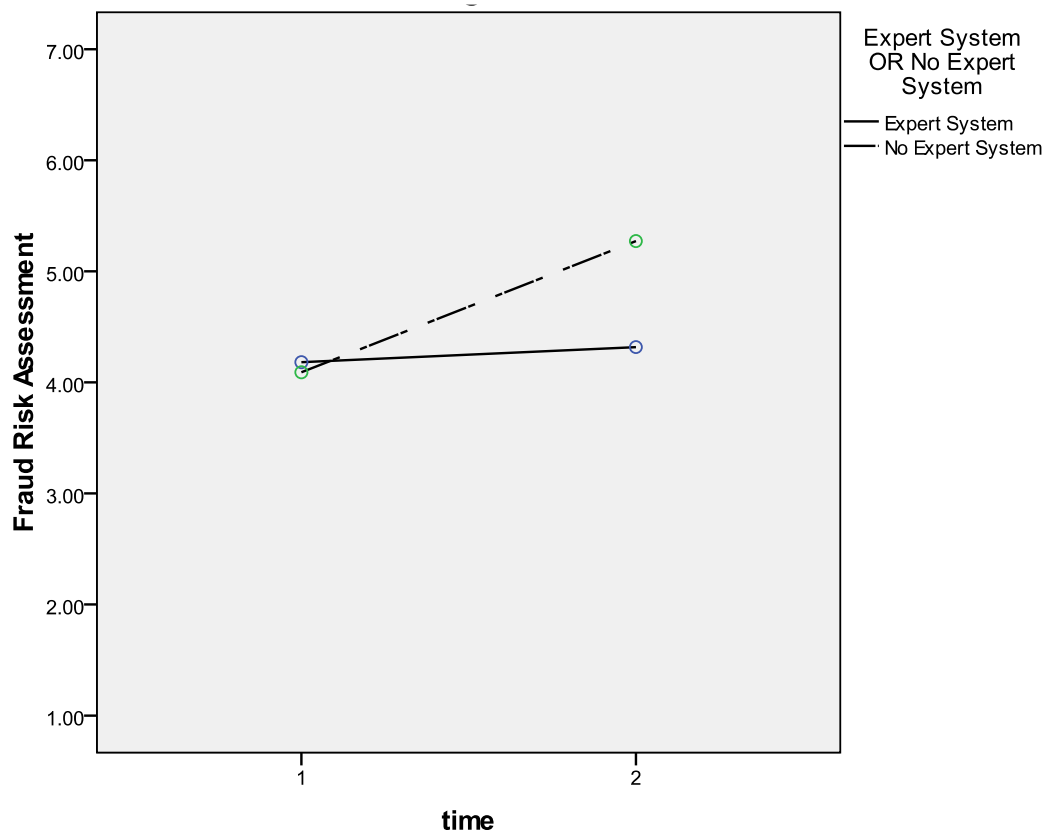
<u>Effect</u>	<u>Test</u>	<u>Value</u>	<u>F</u>	<u>Hypothesis</u> <u>df</u>	<u>Error</u> <u>df</u>	<u>Sig.*</u>	<u>Partial</u> <u>Eta</u> <u>Squared</u>
Time	Wilks' Lambda	0.738	14.904	1	42	<0.001	0.262
Time*Group	Wilks' Lambda	0.818	9.375	1	42	0.004	0.182

\*All p-values are two-tailed.

**Table 11: Mixed Analysis of Variance with Repeated Measures: Within-Subjects Testing for Acceptability Heuristic**

The interaction effect is also shown in the plot (Table 12). The plot also supports that prior to learning partners' views fraud risk assessments of both condition groups were not significantly different with each other; however, after learning the partners' views the fraud risk assessments were significantly different between condition groups.

**Fraud Risk Assessments Prior and After Learning Partners' Views**



**Table 12: Mixed Analysis of Variance with Repeated Measures: Within-Subjects Testing (Interaction) for Acceptability Heuristic**

The main effect, (Table 11), displays a statistically significant effect for time as well ( $F(1,42)=14.904$ ,  $p < .001$ )<sup>15</sup>. This suggests that there was a change in fraud risk assessments across the two different time periods, prior to and after learning partners' views.

The second hypothesis stated the use of an expert system as a decision aid reduces acceptability heuristic bias exhibited by less experienced auditors. This was supported with the between subject results from the mixed model analysis of variance (Table 13).

<sup>15</sup>The effect size is medium to large, as defined by Cohen's guidelines, and each of the differences is significant.

The between-subjects tests supports that there was a significant difference ( $p=.033$ ) between the two conditions for the final fraud risk assessment (after learning audit partners' views).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.*	Partial Eta Squared
Intercept	1755.102	1	1755.102	2088.493	<0.001	0.980
Group	4.102	1	4.102	4.882	0.033	0.104
Error	35.295	42	0.840			

\*All p-values are two-tailed.

**Table 13: Mixed Analysis of Variance with Repeated Measures: Between-Subjects Testing for Acceptability Heuristic**

The results show that use of the expert system mitigated the acceptability heuristic in the condition with the use of the expert system, as the final assessment was significantly different from the condition without the use of the expert system. These findings suggested that the auditors who made assessments with the availability of the expert system were not significantly influenced by learning audit partners' views, unlike the case for the auditors who did not use the expert system<sup>16</sup>.

In addition, a detailed analysis of the fraud risk factors considered (prior to and after learning partners' views) by participants in making initial and final fraud risk assessments.<sup>17</sup> This additional analysis was performed to determine if any other effects were noted (i.e. anchoring, fraud triangle-any factor of more focus, etc.) between participant condition groups (no use expert system and use of expert system) and each

<sup>16</sup> The mixed model analysis of variance was also run with three covariates - years of experience, task experience (making fraud risk assessments), and confidence in fraud risk assessment - and results were quantitatively similar independently and collectively (years of experience:  $p = .030$ ; task experience:  $p = .021$ ; confidence level:  $p = .039$ ; all covariates:  $p = .028$ ).

<sup>17</sup> Fraud risk factors were assessed on a 7-point likert scale (1=extremely unimportant and 7=extremely important).

condition group verses the expert panel. While findings did not demonstrate other effects or characteristics occurring, they do further support learning partners' views is the driving effect in the acceptability heuristic occurring among audit seniors in this situation.

Results also support that experienced auditors (in the expert panel) are not affected by the partners' views.

### **3.5 Conclusions**

This study suggested that the use of an expert system as a decision aid would reduce auditor acceptability heuristic bias that occurs with incorrect partner influence. A 2 (x 2) laboratory experiment was conducted to examine the influence of the use of the expert system on the assessment of fraud risk in counteracting the acceptability heuristic bias.

The first hypothesis stated that less experienced auditors who learn partners' views after they have made a judgment themselves alter their original judgment, aligning it with partners' views. Results supported that the audit seniors in the group without the use of the expert system did align their assessments with that of the audit partners'. The second hypothesis was that using an expert system as a decision aid reduces the acceptability heuristic bias exhibited by less experienced auditors who learn the audit partners' views. This hypothesis was also supported by the results of the experiment.

Significant variances were noted within the condition group without use of the expert system between making the initial (before learning partners' views) and final assessment (after learning audit partners' views), as well as with the final assessments (after learning audit partners' views) between the two condition groups (without and with the use of the expert system). There was no significant difference noted within the condition group who had use of the expert system in making the initial and final fraud

risk assessment. Based on the overall results of the study, an expert system serves as a reliable and appropriate decision aid for auditors' in making assessments in an environment where this bias exists.

Future research can examine what it was about the expert system which mitigated this judgment bias. This can be accomplished with verbal protocol analysis of audit seniors participating in the experiment with the use of the expert system. Also, it would be interesting to compare less experienced auditors who demonstrate the bias (without the use of the expert system) to experienced auditors who do not demonstrate this bias to determine what it is about experience that causes this bias. If a clean template of decision making without bias (via experienced auditors) can be created a comparison can be done between auditor levels, and ultimately a better understanding can be obtained of judgment biases.

## **Chapter 4: Using Verbal Protocol Analysis to Examine the Dilution Effect**

### **4.1 Introduction**

Auditors are responsible for making various judgments based on data obtained during the audit and results reached during fieldwork. The audit environment is unique because auditors have to both develop judgments and then express an opinion on these judgments made during the audit. Making appropriate judgments is critical because auditors may be held liable under federal securities laws or common law. As a result of auditor liability and the uniqueness of the audit environment, much research has been done in the area of auditor judgment and decision making (Joyce and Biddle 1981).

Previous research in auditor judgment and decision making is drawn from psychology-based theories and is mainly concerned with the auditor decision making process and accuracy of auditor judgments, suggesting improvements for making decisions and judgments (Solomon and Shields 1995), and identifying biases in auditor judgments (Tetlock 1983; Kennedy 1993, 1995; Wheeler and Arunachalam 2008). The previous literature in the area of auditor decision making and judgment biases has experimentally examined and generally focused on the outcome accuracy component, as it pertains to biases, of the decision making process (Wheeler and Murthy 2011).

This exploratory study uses process tracing to further analyze the dilution effect demonstrated by less experienced auditors. This study uses a subset of participants from the experiment conducted in Chapter 2 to obtain and offer more insight into the dilution effect and mitigation of it through use of the expert system, AudEx. The dilution effect is a judgment bias which occurs when too much focus is spent on irrelevant information. More specifically, it is a judgment bias in which irrelevant (i.e. nondiagnostic) cues,

when processed along with relevant (i.e. diagnostic) cues causes an evaluator to underweigh the relevant cues (Waller and Zimbelman 2003).

Since prior research demonstrates that less experienced auditors are subject to this bias (Eining *et al.* 1997) and experienced auditors are not susceptible to this specific bias (Shelton 1999), this study used less experienced auditors as participants. The experiment incorporated the use of an expert system, AudEx, as a decision aid because Chapter 2 shows that use of this system mitigated this judgment bias. Auditor decision making process with and without the use of an expert system was captured and analyzed both within and between subjects.

By investigating audit seniors' decision making processes without the presence of the dilution effect (the relevant only information condition group), a clean template of decisions without bias is provided and compared to audit seniors' decision making processes in an environment where the dilution effect is present (the relevant and irrelevant information condition group). This study attempts to provide further insight into the results from Chapter 2.

Participants were asked to think aloud throughout the experiment in order to capture their thought processes. By using verbal protocol analysis, one method of process tracing, to analyze the decision making processes of auditors in an environment where judgment biases exist, a further explanation can be obtained as to why this bias did not occur once the audit seniors had use of AudEx as a decision aid. Verbal protocols have been found to be the most comprehensive and effective technique in analyzing thought processes and capturing problem definitions, hypothesis development and information search (Todd and Benbasat 1987).

Although verbal protocol analysis has been used in the audit literature (Bedard and Biggs 1991; Biggs and Mock 1983; Biggs *et al.* 1987; Rosman *et al.* 2007), it has not yet been used as a tool to analyze and understand judgment biases; as well as compare less experienced auditors' decision making process in an environment without and with the dilution effect present. This study also contributes to the literature by exploring audit seniors' decision making processes with and without the use of an expert system as a decision aid. Chapter 2 shows how an expert system has the capability to mitigate this bias, but it is important to investigate what it is about the system that allows for more appropriate decision making.

Verbal protocol analysis is a process tracing method commonly used in mapping cognitive processes in decision making (Ford *et al.* 1989). It is applied concurrently (during the decision making experiment) in the current study by urging participants to think aloud (verbalize) throughout their decision making. The resulting recordings were transcribed, sectioned, and coded to trace the decision making process. Other fields, such as psychology and education, have successfully applied this approach in measuring decision making from a human information processing standpoint (Ericsson and Simon 1996). Biggs and Mock (1983) introduced verbal protocol analysis to the audit literature and suggest it is a “multimethod investigation of auditor information-processing behavior”. This method attempts to explain in detail one's processing of information and choice behavior.

The process a less experienced auditor follows in making decisions needs to be examined to understand why this specific bias occurs. By examining the less experienced auditor's decision making process, the specific events that led to the occurrence and

mitigation of this bias can be documented and further analyzed. While mitigating this bias is a substantial contribution, it is only a partial response to the problem. If the actual thought process can be identified and understood insight can be offered that allows the profession to look at intervention procedures.

Since previous researchers have shown that the dilution effect predominately occurs in less experienced auditors (Shelton 1999), the present study uses this as a baseline and does not hypothesize to replicate these findings. Instead this study addresses two research questions discussed below.

The next section presents the theory and research questions. The third section describes the methodology and research design. The fourth section explains results and the last section contains the conclusions.

## **4.2 Theoretical Background**

### **4.2.1 Process Tracing**

Process tracing is a form of cognitive task analysis and has been used in examining performance in an extensive range of work situations and decision making literature (Ford *et al.* 1989; Marmaras *et al.* 1992; Covey and Lovie 1998; Patrick and James 2004). Payne (1976) was the first to introduce process tracing within decision making literature. The purpose of process tracing is to provide a way “to map out how the incident unfolded including available cues, those cues actually noted by participants, and participants’ interpretation in both the immediate and in the larger institutional and professional contexts” (Woods 1992). Process tracing is used to further explain how a particular outcome arose and the process taken by the decision maker in reaching that outcome. It assumes an ideographic analytical approach to produce a qualitative

description of how tasks are undertaken and then compared against others actions in similar situations (Patrick and James 2004).

The different methods of process tracing include: information display boards, tracing of eye movements, computer logs, written protocols, and verbal protocols (Todd and Benbasat 1987). Refer to Table 14 for details on each method of process tracing.

<b>Process Tracing Method</b>	<b>Description</b>	<b>Weakness(es)</b>
Information Display Boards	Used in obtaining search patterns shown by individuals when choosing among alternatives in standard choice situations	Only provides information about initial use of information requested
Tracing of Eye Movements	Analyzing eye fixations and duration of fixations to obtain data on different thought process strategies and information use. Overcomes deficiency in information boards	Does not provide direct measures of significance attached to particular items.
Computer Logs	Unobtrusively monitor interactive decision making activity while one is using the system.	Provides no insight specifically related to one's evaluation of available information and only indicates actions taken by one, not paths explicitly considered.
Written Protocols	Provides increased detail on certain processes one takes during information manipulation.	Low density of data collected due infrequent use.

Verbal Protocols	One's thought process is verbalized and recorded for further analysis. Provides access to specific information examined, manipulations conducted on input stimulus, and evaluations made by decision maker.	Refer to limitations noted in 4.2.2 Verbal Protocol Analysis
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**Table 14: Different methods of process tracing<sup>18</sup>**

Verbal protocols have been found to be the most comprehensive technique (Todd and Benbasat 1987); however, any of the methods described above are most beneficial when used in combination, a multi-method approach (Payne *et al.* 1978; Russo 1978). The common procedure used among most multi-method approaches is verbal protocol. The current study uses verbal protocol analysis combined with computer logs for optimal results. This specific combined multi-method approach has proven to be successful in previous studies (Botkin 1974).

#### **4.2.2 Verbal Protocol Analysis**

Verbal protocol analysis is used for collecting and analyzing verbal information about cognitive processing. This can be accomplished by having participants think aloud throughout performing a task and taking a detailed record of one's thought process. This proves to be a useful and most powerful tool in analyzing thought processes and capturing the dynamics of problem definitions, hypothesis development, and information search during decision making (Todd and Benbasat 1987). Verbal protocol provides suggestions regarding why data was accessed, importance assigned to data, and techniques used in analyzing the data (Todd and Benbasat 1987).

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<sup>18</sup> Information obtained from Todd and Benbasat (1987).

Verbal protocol analysis is used in this study to understand decision making processes of audit seniors in identifying trigger points related to a judgment bias, as well as auditors' interactions with an expert system as a decision aid. Although this method had been used early on (Dunker 1945; DeGroot 1966) as a way to measure decision making from a human information processing standpoint; it was not until Newell and Simon (1972) that this method became a formal methodology.

Concurrent neutral probing verbalization is the most acceptable method used for verbal protocol data collection (Ericsson and Simon 1984); which is the method of verbal protocol analysis utilized in the current study. Concurrent protocols are when participants think aloud while performing a task (Todd and Benbasat 1987). Concurrent verbalization is deemed more valid than retrospective verbalization, as long as careful instructions are given on how to think aloud and warm-up exercises are provided as practice (Ericsson and Simon 1996). Neutral probing asks for a description of the process and captures the individual's natural thought process (Todd and Benbasat 1987). Verbal protocols should also be used in conjunction with other data to increase validity (Patrick and James 2004).

Verbal protocol analysis has been used in studying the interaction between users and decision support systems, such as expert systems (Sundstrom 1991; Todd and Benbasat 1987). Decision support systems are "computer-based systems that help decision makers confront ill-structured problems through direct interaction with data analysis and models" (Todd and Benbasat 1987). For example, Mao and Benbasat (2000) conduct an exploratory investigation to identify factors that influence users' decision making during interaction with an expert system. This study revealed that there

were quantitative and qualitative differences between novices and experienced professionals in the nature and extent of assessments.

Todd and Benbasat (1987) identify research issues that decision support systems can assist in exploring. These issues also support the current study in applying verbal protocol analysis to capture thought processes in making decisions with and without the use of an expert system. The first is the need to understand decision making behavior in order to identify biases and inconsistencies in thought processes. If this can be understood then one will know the types of decision aids to develop which can alleviate these deficiencies. Also, the structuring of problems presented by systems can assist one in learning heuristics, methods, and information sources the user of the system utilized in solving problems.

Another characteristic of systems is the capability of interaction with its users throughout making decisions. This interaction with the user supports systems' unique characteristics of being a learning tool as well as decision aid. AudEx, the expert system used in the current study, captures advanced human-computer interface; meaning a person can interact with the computer as if it is a human and the computer learns as the person is talking to it. One last research issue Todd and Benbasat (1987) suggest is that support systems can assist in improving and capturing a decision maker's effectiveness. A support system's assessment is based on the user's decision making process and output measures. The authors conclude verbal protocol analysis is essential to understanding the interaction of decision making with use of a support system.

In general, researchers have shown that individuals rely on question lists in searching for information, relate data found to examples of problem outcomes in one's

associate memory, and organize patterns of information by using a small amount of hypothesized solutions in searching for further information (Payne 1976; Elstein *et al.* 1978; Bouwman 1983; Biggs 1979; Biggs and Mock 1983). These prior studies also recommend decision support aids to remedy problems identified in decision making thought processes such as checklists, fault trees, and computer assisting aids. Psychology studies have used computers as a tool to model human cognitive functions (Todd and Benbasat 1987) and the accounting literature has adopted these strategies.

Based on the findings in the previous literature, verbal protocol analysis overall provides “relatively complete data on a subject’s task-related behavior that is relatively high in temporal density” (Biggs and Mock 1983); however, it is not without its criticisms. The following four issues are the main ones related to this type of analysis: (1) use of verbal reports, (2) if the act of verbalizing affects the course and structure of cognitive processes, (3) if verbal reports are complete records of cognitive processes, and (4) degree of subjectivity of coding methods (Biggs and Mock 1983; Ericsson and Simon 1980).

Verbal reports are participants’ oral responses which represent behavioral information, serving as evidence about cognitive processes (Ericsson and Simon 1980). These reports are heavy with detail giving an advantage in obtaining behavioral support in complex tasks (Biggs and Mock 1983). Next, since verbal protocols do not require special probes or verbalizing after completion of the task, verbalizing during the task does not affect the course and structure of cognitive processes (Ericsson and Simon 1980). Russo *et al.* (1986) prepare a meta-analysis of previous studies which utilized concurrent verbal protocol analysis. The authors conclude overall that concurrent verbal

protocols do not significantly change a primary decision process. For example, Schweiger (1982) finds simultaneous verbal protocols are accurate and do not interfere in one's decision making processes.

Regarding the third issue, although some information of the participant's behavior may be missing, the unavailable information does not invalidate the data that is present (Ericsson and Simon 1980). Lastly, the key to reducing subjectivity is to specify the rules of coding in advance of the actual coding (Biggs and Mock 1983). For example, there should be more than one coder independently applying the coding rules in order to achieve reliability in consensus among coders. Also, by making the rules of coding available, their logic can be assessed by readers.

This method of analysis is sparse in the audit literature, but when used it has proven to be significantly effective (Biggs and Mock 1983; Biggs *et al.* 1987; Bedard and Biggs 1991; Bierstaker *et al.* 1999; Wright and Bedard 2000; Rosman 2007). Biggs and Mock (1983) are one of the earlier audit studies to use verbal protocol analysis to experimentally examine how less experienced auditors assessed internal controls (Biggs and Mock 1983). This study was based on an earlier study by Mock and Turner (1981), which find significant variability in less experienced auditors' decisions in performing an identical experimental task. Biggs and Mock (1983) replicate results of Mock and Turner (1981), in that auditors' assessments varied; but Biggs and Mock (1983) are able to identify those variables with a think aloud process which could explain the majority of the variance in decision making. Those variables were: information search strategy, internal control reliance, alternatives considered, and decision heuristics. Also,

participants' reasoning activity mostly took place in the information search and evaluation stages.

Similar to Biggs and Mock (1983), the current Chapter builds off of Chapter 2 in exploring why less experienced auditors demonstrate the dilution effect. Chapter 2 not only demonstrates this bias occurs at the audit senior level, but also mitigates it using an expert system, AudEx, as a decision aid. This study also investigates the decision making process within and between less experienced auditors without and with the use of an expert system in environments where this bias does not and does occur.

### **4.2.3 The Dilution Effect**

Research suggests auditors may be different types of decision makers in different environments (Payne 1982). That being the case, audit judgment and decision making is categorized into four basic types of activities: (1) evaluations or judgments of current information; (2) predictions of future outcomes; (3) assessments and revisions of the probabilities that particular outcomes will occur; and (4) choices among alternative courses of action (Ashton 1984). All four activities in auditor decision making are susceptible to judgment heuristics, which can lead to biased decisions. These activities serve as the basis for evaluating the decision making process in the current study. For a summary listing of auditor judgment biases refer to \*Audit study

Table 1.

Accountability has been shown to mitigate most of these judgment biases; however, two were exacerbated, not mitigated, by it – the dilution effect (Quilliam 1993; Hackenbrack 1992; Buchman *et al.* 1994; Tetlock and Boettger 1989) and acceptability heuristic (Gibbins and Newton 1994; Koonce *et al.* 1995; Peecher 1996; Peytcheva and Gillett 2010). The current study focuses on dilution effect. Previous research does have

some mixed findings regarding the effect of accountability on the dilution effect; however, none of the findings show accountability to mitigate this bias.

The dilution effect is “a judgment bias in which the presence of nondiagnostic (i.e. irrelevant) cues, when processed along with diagnostic cues, causes a judge to underweigh the diagnostic cues” (Waller and Zimbelman 2003). According to Hoffman and Patton (1997), “the dilution effect is an example of a judgment bias that is not expected to be corrected by exerting additional effort in performing a task (i.e. a perceptual problem)”.

The dilution effect occurs in less experienced auditors (Hoffman and Patton 1997). Audit research shows that auditors are susceptible to the dilution effect when faced with relevant and irrelevant information (Eining and Dorr 1991; Nisbett *et al.* 1981; Hackenbrack 1992; Seow 2009; Glover 1997; Hoffman and Patton 1997; Eining *et al.* 1997; Eining and Jones 1997; Waller and Zimbelman 2003). This negative behavioral effect leads to auditors spending excessive time developing inappropriate judgments, which results in increased time and costs due to excessive and inefficient auditing. Auditors lean towards making conservative judgments based on the audit environment and their training; however, this may lead to their failing to uncover material errors (Smith and Kida 1991). Auditors tend to think that making more conservative judgments will be easier to justify to superiors, whether appropriate or not (Morton and Felix 1991).

The current study utilizes verbal protocol analysis to analyze the following two research questions:

**RQ1:** How and/or when does the dilution effect bias occur in less experienced auditors?

**RQ2:** How do expert systems mitigate the dilution effect bias?

## 4.3 Methodology and Research Design

### 4.3.1 Participants

There were 12 participants in this study (six auditors in each of the two treatment groups). The participants were a subset (26%) of the 46 participants used in Chapter 2 and spoke aloud during the experiment in the current study. This sample size is large compared to other verbal protocol studies (Biggs and Mock 1983; Klersey and Mock 1987; Johnson *et al.* 1989; Wright and Bedard 2000), both in and outside of audit studies, and in line with the sample size of Rosman *et al.* (2007). The participants were audit seniors from a regional public accounting firm. Years of work, fraud risk assessing experience, level of confidence in overall fraud risk assessment, and familiarity with SAS 99 and the checklist that supports it were asked of participants in the post experiment questionnaire. Participants' averaged 4.6 years of experience and averaged making 10.5 fraud risk assessments in the last three years.

Participants input all data electronically into the computer and expert system when applicable. Participants were randomly assigned one of the two treatment condition groups - relevant only information or relevant and irrelevant information - and had to assess the fraud risk of the fictitious company provided in the case study. The participants in the relevant only information condition group had a higher level of confidence ( $M=5.5$ ) when compared to the relevant and irrelevant information condition group ( $M=4.3$ ); however, the means are not significantly different ( $p=.014$ ). All participants were told they were being held accountable for their assessments and had to justify their final fraud risk assessment. Participants were prompted to input their names as the user log-in by the computer and experimenter. This was to insure accountability was employed consistent with previous studies (Peecher 1996; Lord 1992).

### 4.3.2 Experimental Design

The experiment was an extension from Chapter 2. The following additions were made to the experiment for the purpose of this study: (1) conducted for each participant individually and (2) participants were asked to think aloud throughout the entire experiment. Previous literature has shown that less experienced auditors experience the dilution effect in the presence of relevant and irrelevant information. If less experienced auditors' thought processes in a decision making environment where this bias occurs can be analyzed, both without and with the use of a decision aid (i.e. expert system), specific trigger points can be identified as possible causes as to why less experienced auditors demonstrate these judgment biases and what it is about using the expert system that led to the mitigation of this bias.

The controlled laboratory experiment was conducted on an individual basis in a conference room, free from outside noise and distraction, at the participants' home offices. They were done individually so each session could be recorded to capture each participant's thought process throughout the experiment. Participants were asked to think aloud so their thought processes could be captured and further analyzed. The think aloud instructions followed Ericsson and Simon's (1980) "Level One" verbalization in order to minimize interference in the task performance caused by participants thinking aloud. All sessions were recorded and transcribed so a verbal protocol analysis could be performed. The experimenter was present during all individual sessions to remind participants to think aloud, if they fell silent for long periods of time.

A 2 (x 2) repeated measure design was employed to examine auditors' thought processes in making decisions on assessing fraud risk (Figure 1 and Figure 2). The type of information (relevant only information or relevant and irrelevant information) was

manipulated between groups. Use of the expert system was a within-subjects variable with participants first making a decision without the expert system and then revising their decision after completing the case with the assistance of an expert system.

There were two different versions of the case study and each condition group received one version. The participants in the relevant only condition group obtained only relevant information cues (6 relevant cues), and the participants in the relevant and irrelevant information condition group obtained all of the relevant cues, as well as some irrelevant information cues (6 relevant and 4 irrelevant cues). The participants were first asked to develop an initial assessment and rate the factors that contributed to that assessment. This was done without use of an expert system.

The expert system then took the participants through a series of questions, in line with the SAS 99 fraud risk indicators (all participants were greatly familiar with SAS 99 and the fraud risk factors as indicated in the post-experimental questionnaire), containing cues relevant to indicating fraud, but only some were present in the specific case. That was followed by the expert system taking participants through a comparison of the participants' and the expert system's assessments of each fraud risk indicator, with the expert system stating rationales and sources (i.e. SAS 99) used to assess each indicator.

Lastly, the system reminded participants of their initial assessment and asked if they would like to change their evaluation. The system did not provide an overall fraud risk assessment to avoid creating another bias, the acceptability heuristic. If the less experienced auditor learned the assessment of the system or the audit partner, literature has shown they will align with that assessment (Peytcheva and Gillett 2011). By the system not just telling the auditor what the appropriate assessment the reasoning behind

the auditor changing from the initial assessment is due to the process of using the expert system and not because they learned the assessment. Ultimately, the overall fraud risk assessment needed to be justified by the participants, regardless if changed or the same from the initial fraud risk assessment. At the end of the experiment, participants were shown the expert system's overall fraud risk assessment compared to their own; however, participants were not able to make any changes. Lastly, participants were asked to provide feedback and demographical information via a post experiment questionnaire.

There were two reasons the experiment was designed in this way. First, this experiment was meant to mimic the real-life process of assessing fraud risk on an audit, so the participants were able to relate to the steps in the process during the experiment. Second, a similar method was used by Hunton *et al.* (2010) with the purpose of capturing reliance on the decision aid. Hunton *et al.* (2010) captured this by having the participants evaluate the information and make an initial assessment before using the decision aid. Then participants were asked to make a final assessment after using and reading the recommendations of the decision aid. By recording the participants' initial and final assessments, as well as the decision aid's assessment, the researchers were able to create a metric for reliance on the decision aid.

Wheeler and Murthy (2011) analyze decision aid research performed previously and highlight positive and negative points about the research overall (i.e. experimental design, research question, operationalization, etc.). The authors note that this type of experimental design (embedded control of no decision aid) is beneficial because no valuable information can be gathered from a control group without a decision aid. This within-subjects design has advantages (each participant has an individual control) and

disadvantages (potential demand effects), but should be considered in decision aid research experimental designs (Wheeler and Murthy 2011).

### **4.3.3 Development of Cases**

The case used in this Chapter was the same as in Chapter 2. The case was obtained from Wilks and Zimbelman (2004) and modified it for the purposes of this study. In the current study, one of the two versions of the case was distributed to participants. One containing relevant only information and the other containing both relevant and irrelevant information. Refer to Appendix A: Dilution Effect Case and Instruments for the fraud risk case distributed to participants.

An expert panel of 20 audit managers and partners (averaging 9.8 years of experience) reviewed and evaluated the case materials validating the case, cues, and overall assessment. Each expert was randomly assigned to one condition group, totaling ten experts in each condition. The experiment was also pilot tested on a group of 40 graduate level audit students. The participants were randomly assigned to one of the two condition groups, totaling 20 participants in each group. The pilot test was completed in a controlled laboratory environment and ran the same way as the actual experiment. For details of the testing completed with the expert panel and the pilot test refer to Chapter 2 (2.3.3 Development of Case).

### **4.3.4 Models**

#### ***4.3.4.1. The Expert System***

The particular hybrid expert system, AudEx, used in this study captures the improvement in technology by containing the capability to be trained by human experts. This is done by the system retaining data provided and work performed that the expert input, as well as rules, regulations, and procedures manually inputted into the system.

With this training, the system can produce the same assessments the actual auditor would have produced. The system can perform more efficiently and less costly in the long-run, while creating a substantially raised base line and consistent audit that can then be reviewed by the actual auditor. For a detailed description of the expert system AudEx, refer to Appendix C and Chapter 2 (2.3.4 Model).

#### ***4.3.4.2 Verbal Protocol Analysis***

There are four categories of protocol analysis: (1) scanning, (2) scoring, (3) global modeling, and (4) computer simulations (Bouwman 1983). Scanning is the most straightforward method which is used in helping to interpret statistical models. Scoring requires the development of coding schemata to break down protocols and tabulate frequencies of specific occurrences. Global modeling directly examines the problem solving processes and identifies the order of actions. Computer simulation develops a model to accurately represent and replicate individual's decisions by following the same pattern of reasoning of the individual.

This study followed Ericsson and Simon's (1984, 1996) protocol procedures in obtaining, coding, and analyzing verbal protocols. Chi (1997) provides different approaches to conduct quantitative analysis of these reports and the current study follows those suggested guidelines for quantifying the different relationships within the verbal protocols. A concurrent verbal protocol method was used in this current study along with combining verbal protocol with computer logs. Since the experiment was conducted via the use of a computer, it was possible for individuals' thought processes to be captured through the use of computer logs as well as verbal protocol.

Participants met individually with the researcher in a conference room at their place of business. The information to participants included instructions to think aloud

throughout the experiment. The researcher remained present to remind participants to think aloud if they were quiet for a while or seemed to forget. All participants were recorded and verbal protocols were transcribed and reviewed for accuracy.

The verbal protocols were divided into phrases by means suggested by Ericsson and Simon (1984, 1996). For example:

- 34. If they have marginal ability to make debt payments
- 35. I would consider this to be a fairly significant fraud risk
- 36. especially in our current economic climate
- 37. I keep going back to but the current debt crisis that faces many companies
- 38. and many individuals
- 39. is a very important factor
- 40. so based on looking at the above information
- 41. it does not seem overly indicative that they might have trouble
- 42. being their assets have been somewhat going up since 06 through 09
- 43. and that their net income was increasing
- 44. so I would presume they are set to make their debt payments;
- 45. however, if they were not able to or something would hinder this
- 46. I would consider this a very important factor
- 47. so I would rate that as a 6.

The rules of coding followed Biggs and Mock (1983) and Rosman *et al.* (2007) in grouping coding rules into task related categories and distinguishing between navigation and processing activities. The current study's task was similar to Biggs and Mock's (1983), as they had participants make internal control assessments. Information obtained was evaluated based on the following four activities: (1) task structuring; (2) information acquisition; (3) analytical; and (4) action. The last operator under the action category, specific reasons/factors stated, was broken out into more specific operators categorized as financial or non-financial related factors. Two coders independently analyzed the transcriptions and a third was used to reconcile any differences.<sup>19</sup> The Kappa

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<sup>19</sup> An agreement matrix was computed for the coded transcripts. These were independently coded by both the researcher and the graduate student, and then

Coefficient in this study ( $Kappa = .794$ ,  $p < .001$ ) is significant and supports substantial agreement between the coders (Landis and Koch 1977). All differences have been resolved by a third independent coder. Refer to Appendix D: Operators and Their Definitions Used in Coding of Verbal Protocols for the specific activity codes used in the coding of the subjects' transcriptions.

#### **4.3.5 Dependent Variables**

There are two separate dependent variables: (1) final judgment - auditor's assessed level of fraud risk and (2) verbal protocol analysis outcomes.

#### **4.3.6 Manipulated Variables**

All participants were asked to think aloud during the entire experiment so the step-by-step decision making process could be documented for further analysis. Also, at the end of each experiment all participants were given a post-experiment questionnaire to assist in analyzing their thought processes.

The first independent variable was use of the expert system. This was a within subjects variable with participants first making a decision without the expert system and then revising their decision after completing the case with the assistance of an expert system. The second independent and manipulated variable was relevance (relevant only information or relevant and irrelevant information). This variable was manipulated between groups. The variable controlled for throughout all conditions was accountability.

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summarized into a combined agreement matrix (Biggs 1978). The Kappa Coefficient was 81.55%; which means each coder assigned the same operator 81.55% of the time.

## **4.4 Results and Discussion**

### **4.4.1 Statistical Results**

Chapter 2 (2.4 Results and Discussion) showed that the dilution effect did occur in the group with relevant and irrelevant information, and significantly mitigated this bias with the use of the expert system, AudEx. There were three benchmarks to compare the overall means of the fraud risk assessments to: Wilks and Zimbleman (2004), the expert panel, and the expert system.

In Wilks and Zimbleman's (2004) study, the participants were audit managers and senior managers from Big 4 public accounting firms, averaging an overall fraud risk assessment of 3.92. The expert panel of audit managers and partners from a regional public accounting firm had an overall fraud risk assessment averaging 3.85. Lastly, the expert system determined that the overall fraud risk assessment was 4.0. There were no significant differences among the three separate benchmarks (Table 15). The only significant differences noted were between the three benchmarks (Wilks and Zimbleman (2004), the expert panel and the expert system) and the relevant and irrelevant information condition group's initial assessments ( $p=.026$ ,  $<.001$ , and  $.031$ , respectively). All final assessments for both groups were not significantly different from any of the three benchmarks.

**Panel A: Relevant Only Information Group**

	No Expert System (Initial)		Expert System (Final)	
	T score	p-value*	T score	p-value*
<b>Wilks and Zimbleman (2004)</b>	0.083	0.937	0.303	0.774
<b>Expert Panel</b>	0.388	0.701	0.850	0.404
<b>Expert System</b>	0.000	1.000	0.205	0.846

**Panel B: Relevant and Irrelevant Information Group**

	No Expert System (Initial)		Expert System (Final)	
	T score	p-value*	T score	p-value*
<b>Wilks and Zimbleman (2004)</b>	3.131	0.026	0.303	0.774
<b>Expert Panel</b>	5.131	<0.001	0.850	0.404
<b>Expert System</b>	2.988	0.031	0.205	0.846

\* The p-values are two-tailed.

**Table 15: Means Compared**

In addition, a detailed analysis was performed of the fraud risk factors considered (prior to and during use of expert system) by participants in making initial and final fraud risk assessments.<sup>20</sup> This type of analysis, analyzing specific factors, has not been demonstrated in prior audit literature to further support the dilution effect occurring. While previous researchers have concluded that the dilution effect occurs, they have not

<sup>20</sup> Fraud risk factors were assessed on a 7-point likert scale (1=extremely unimportant and 7=extremely important).

investigated the specifics of why the effect occurs or the factors that led to its occurrence (Shelton 1999; Glover 1997; Hoffman and Patton 1997).

This additional analysis was also performed to determine if any other biases were noted (i.e. anchoring, fraud triangle-any factor of more focus, etc.) between participant condition groups (relevant only information and relevant and irrelevant information ) and each condition group verses the expert panel. While findings did not demonstrate other effects or characteristics occurring, they do further support that irrelevant information is the driving effect in the dilution effect occurring among less experienced auditors.

The untabulated results from comparison of the means (t-tests) show no significant differences in the means of the relevant information and significant differences in the means of irrelevant information. In fact, between the two participant condition groups there was almost no difference at all in the assessments of the relevant information; therefore, the difference between initial fraud risk factors was due to the relevant and irrelevant information condition group factoring the irrelevant information into the initial fraud risk assessments (the dilution effect).

Both condition groups were under weighing relevant factors when compared to the expert panel group; however, both condition groups still had an increased overall fraud risk assessment. The three most underweighted factors (in order from most to least underweighted) related to global operations of the company, the company having marginal ability to meet debt repayment requirements, and high degree of competition or market saturation accompanied by declining margins. If less experienced auditors are under weighing relevant factors (i.e. do not realize the importance of them), yet assessing fraud risk at the appropriate level (increased weight compared to the weights of the

relevant factors) how would this translate into audit tests? A possible explanation, which is further evidenced in the results of the protocol analysis (in section 4.4.2 Protocol Results) is that less experienced auditors are mismatching the type of risk the factor represents (i.e. audit risk, business risk, fraud risk).

Most of the irrelevant factors were risk factors; however they were not fraud risk factors. The audit seniors did realize that they were important factors that should be considered in the audit, but before using the expert system they were identifying them as fraud risk factors and overrating them as compared to the actual fraud risk factors. The expert system did assist in the audit seniors' realization of incorrectly identifying the type of risk, as evidenced in the transcripts relating to the rationale for assessment of the final fraud risk factor.

#### **4.4.2 Protocol Results**

Participants' protocols were independently examined and coded by two different researchers. The Kappa Coefficient in this study (81.5%,  $p < .001$ ) is in the mid to upper range reported in other studies and all differences in coding were resolved by a third independent person. Areas where consensus was obtained between both researchers were used in assessing reliability of the coding techniques employed. Participants performed a practice exercise in thinking aloud so they could gain some level of comfort with this method. The instructions provided to participants conform to "Level One" verbalization (Ericsson and Simon 1980) in an effort to minimize the interference in task performance while thinking aloud. A total of approximately 10,500 lines were coded and analyzed (approximately 1,400 operators). Operators are "information processes that produce new knowledge from existing knowledge" (Biggs *et al.* 1997). For a summary of overall results refer to Appendix E: Summary of Overall Results - Relevant Only Information

## Participants and Appendix F: Summary of Overall Results - Relevant and Irrelevant Information Participants.

A review of operators in the four main activity groups revealed that operations used the most to the least, respectively, for the condition group with relevant only information were: Action (38.34%), Information Acquisition (11.96%) and Analytical (11.96%), and Task Structuring (8.7%). For the condition group with relevant and irrelevant information the operations used in order from most to least were: Action (57.46%), Information Acquisition (15.1%), Task Structuring (7.56%), and Analytical (7%). The area with the overwhelming majority of operators for both condition groups was Action.

As participants were going through the task, the ones in the relevant only information condition group made more inferences (11%) than queries (1%); however, the other group had more queries (4.4%) than made inferences (2.8%). This finding was not surprising because the condition group with irrelevant information was expected to have more questions as the case information was more complex due to the addition of the irrelevant information. When comparing the two groups' Information Acquisition area, both were in-line with each other with facts from the case (4.92% - relevant only information; 4.97% - relevant and irrelevant information) having more operators than facts from external information sources (1% - relevant only information; 0.2% - relevant and irrelevant information). Again, these results are in-line with expectations.

The operators of focus under the Action area were no revision, downgraded, and upgraded. This was because these operators are the main components in deciphering when and where participants made changes, if any, in assessments made throughout the

task. The order of most stated to least stated was the same for both condition groups (relevant only information or relevant and irrelevant information, respectively); which was upgraded (1.9% and 3.5%), downgraded (1.3% and 1.8%), and no revision (0.8% and 1.1%). It was expected that the relevant and irrelevant information condition group would have significantly more downgraded and upgraded operators than the group with relevant only information; and although the relevant only information condition group did exhibit Actions, they were ultimately less than the relevant and irrelevant information condition group. This finding supports that regardless of the type of information, the expert system was useful in making a fraud risk assessment.

The total financial related factors/reasons mentioned by participants in both groups was not significantly different ( $p=.108$ ) between groups. The relevant only information group averaged a total of 9.5% financial related factors out of all other operators, while the relevant and irrelevant information condition group averaged a total of 6.33% financial related factors out of all other operators stated. However, the specific financial factors varied between the groups.

The most mentioned financial related factors/reasons among participants were: (1) relevant information only condition group: Debt (14.99%), Sales/Revenue (13.15%), and Profitability (6.01%); and (2) relevant and irrelevant information condition group: Fixed Assets (11.31%), Sales/Revenue (9.57%), and Debt (8.81%). While two of the three factors did overlap, the third did not because the participants in the relevant and irrelevant information condition group focused the most on fixed assets (an irrelevant piece of information provided in the case information). This was expected because before using

the expert system, participants in the relevant and irrelevant information condition group exhibited the dilution effect.

Fixed assets, an irrelevant fraud risk factor, was mentioned and focused on the most of any factors in the case in making the initial fraud risk assessment (pre-expert system use). Some participants internally debate this factor by stating it is a high risk factor, then saying that it could cause errors but not fraud, then noting it is a business risk, and finally determining it is a fraud risk factor. It appears the audit seniors are correctly identifying risks in general, but having difficulties categorizing them (i.e. audit risk, business risk, fraud risk). For example:

Participant 8

- 857.** I am just reading over the information
- 858.** the first thing I noticed is that they don't keep their fixed assets maintained on the computer,
- 859.** it's manual which can lead to a significant error,
- 860.** well not fraud but an error.
- 861.** Actually it could lead to fraud too.

The total amount of non-financial related factors/reasons mentioned by participants in both groups were also not significantly different ( $p=.147$ ) between groups. The relevant only information condition group averaged a total of 17.77% of non-financial related factors out of all other operators, while the relevant and irrelevant information condition group averaged a total of 16.35% of non-financial related factors out of all other operators. Both groups did state more non-financial related factors than financial. However, the specific financial factors varied between the groups.

While the participants did not significantly differ in the total amount of financial and non-financial factors stated between the groups, they did differ significantly within the groups. The relevant only information condition group significantly ( $p=.008$ ) stated

more non-financial related factors than financial related factors overall. The same finding holds true for the relevant and irrelevant information condition group ( $p=.011$ ). While in total the groups were comparable, they differed in the specific factors mentioned by participants.

The top three non-financial related factors/reasons mentioned among the participants were (most mentioned first): (1) relevant only information condition group: Competition (17.03%), Management Integrity (13.71%), and Organization Structure (10.53%); and (2) relevant and irrelevant information condition group: Management Integrity (25.92%), Controls (13.69%), and Competition (13.46%). Again, two of the three reasons/factors overlapped between groups.

Although it may appear that the percentage of the most mentioned financial related factors were in-line between groups, the relevant only information condition group (34.15%) mentioned these main financial factor operators significantly more ( $p=.001$ ) than the relevant and irrelevant information condition group (29.69%). This was the opposite for the most mentioned non-financial factors. The relevant only information condition group (41.27%) mentioned these main financial factor operators significantly less ( $p<.001$ ) than the relevant and irrelevant information condition group (53.07%). Overall, the condition group with relevant and irrelevant information focused more on non-financial factors than the relevant only information condition group, and vice versa for financial factors.

In reviewing the transcripts, the relevant only information condition group focused the most on management integrity, controls, and sales in making the initial assessment. The focus shifted to debt, organization structure, and customers in making

the final assessment. A few excerpts from the transcriptions which support this finding are as follows:

**Participant One:**

***Initial***

1. For my risk assessment I am going to put it as moderate for the following reasons:
2. it is not high in my opinion
3. because of our assessment of management and our previous experience with them,
4. being that we've worked with them in the past
5. and have a sense of their management structure in place
6. and their controls,
7. I would say that it kind of lowers their risk
8. and gives us further assurance that their controls in place are probably operating effectively
9. and the reason I am not putting it as low
10. because the company has been increasing its sales
11. and that is always a fraud risk being it has jumped from \$1.8M to \$210M,
12. additionally the risk recently in current years based on looking at past financial data
13. is their sales have continually increased in 08 to 10
14. despite the economy dropping during this time period.

***Final***

427. Slight increase in the fraud assessment
428. due to the additional information of the declining customer demand
429. as well as the marginal ability to make debt payments
430. therefore I increased my assessment due to those two additional factors.
431. So those are the main two reasons why I would slightly increase from my initial.

**Participant Two:**

***Initial***

432. I'm thinking the material risk to the financial statements
433. it seems like they have controls in place,
434. but I'm guessing whoever prepares the financial statements didn't go into too much detail about that
435. or any of the controls actually in place,
436. but there seems like there is proper segregation of duties
437. based on the management team's background
438. and the various positions that are outlined in the management background field I went through.
439. I guess my options here
440. I would say that the overall risk of financial statement fraud is probably somewhat low or moderate.

***Final***

578. The company has marginal ability to meet debt repayment requirements,  
 579. I figured I would get something in that category wrong  
 580. as I obviously don't deal with companies that have  
 581. I don't think I've ever had a client that had debt repayments  
 582. or anything so I was kind of unfamiliar with that area.  
 583. That is pretty much where my red is across the board.

...

602. Based on the question and my responses,  
 603. it made me realize that there were several areas of high risk,  
 604. that I initially did not pick up.

**Participant Four:*****Initial***

667. I guess considering we have been auditing the company for 8 years  
 668. and management  
 669. there is good quality by management  
 670. based on what the audit partner is saying  
 671. it seems like they're integrity is impeccable according to the audit partner,  
 672. they have good leadership,  
 673. they have all been there for numerous years -  
 674. it seems like they have been growing year after year  
 675. there hasn't been a significant increase in sales year over year  
 676. and their net income as well as their total assets have been increasing  
 accordingly with everything else  
 677. I guess with that said I would say their risk of material financial statement  
 fraud for the company is somewhat low

***Final***

728. The company may have marginal ability to meet debt requirements  
 729. I guess it's very important  
 730. because in case they have to meet their debt requirements

The relevant and irrelevant information condition group focused on fixed assets, sales, and management integrity in making an initial fraud risk assessment. Although those are the most mentioned operators, it is important to point out that most of the participants in this group mentioned many of the irrelevant pieces of information in making their initial fraud risk assessment and abandoned them in making their final fraud risk assessments. The fixed assets factor was an irrelevant factor in determining fraud risk; however, it was outweighed in importance in making an initial fraud risk

assessment, as compared to the expert panel of auditors. The most mentioned operators in making their final risk assessments were global operations, competition, management integrity and industry. The following excerpts support this result:

**Participant seven:**

***Initial***

- 857. I am just reading over the information –
- 858. the first thing I noticed is that they don't keep their fixed assets maintained on the computer,
- 859. it's manual which can lead to a significant error,
- 860. well not fraud but an error.
- 861. Actually it could lead to fraud too.
- 862. Everyone seems competent,
- 863. the CEO the CFO according to this says that they are all competent and honorable

***Final***

- 966. Ok let's see.
- 967. High degree of competition or market saturation accompanied by declining margins
- 968. I had as neutral
- 969. but IT had it as extremely or important to extremely important.
- 970. Ok I don't know.
- 971. I should have considered the nature of the industry more when I was going through it for the risk of fraud.
- 972. That I didn't consider at all,
- 973. but I should have considered the international borders
- 974. and how there is differing businesses
- 975. because they did say that they were a global firm,
- 976. global company
- 977. but I was looking at it
- 978. just wasn't looking at it from a global point of view.

**Participant nine:**

***Initial***

- 1121. So the first thing that I noted was that the company's sales had been going up in the last 20 years,
- 1122. a little bit slowing down in the last few years.
- 1123. They need some improvement in their marketing, sales, and customer service to stay competitive in the industry.
- 1124. They may struggle repaying their debts
- 1125. so that creates a little bit of risk from an audit perspective.
- 1126. Overall economy and industry are decreasing.
- 1127. Net income in the last year has gone down
- 1128. despite the increase in sales and decrease in net assets.

1129. Of course there was a note about fixed assets,  
 1130. the way they track them manually  
 1131. it's not even in a spread sheet.

**Final**

1226. the company's fixed assets...  
 1227. which is interesting because I kind of changed my answer regarding the  
 fixed assets not being on the computer.  
 1228. I realized that although they are on paper  
 1229. there is not a fraud risk.  
 ...  
 1246. the main risks are  
 1247. the debt repayment  
 1248. and inconsistency with the overall industry

The main reason given as to why participants changed their initial fraud risk assessment was due to the process of reviewing their individual factor assessments compared to the expert system's suggested range and re-reasoning through them. However, it was not just a matter of conforming to the system because they were actually re-thinking through the significant fraud risk factors and stating reasons why they initially under or over weighed them in making the initial fraud risk assessment. Refer below for some excerpts from the transcripts which support this finding:

**Participant 2**

578. The company has marginal ability to meet debt repayment requirements,  
 579. I figured I would get something in that category wrong  
 580. as I obviously don't deal with companies that have  
 581. I don't think I've ever had a client that had debt repayments  
 582. or anything so I was kind of unfamiliar with that area.  
 583. That is pretty much where my red is across the board.  
 ...  
 598. Given this feedback would you like to change...  
 599. I'm going to say I'm going to bump it to moderate  
 600. because after going through some of the questions it makes you realize  
 certain aspects that I responded seem to be more very important or  
 somewhat important  
 601. rather than moderate or unimportant.

**Participant 5**

846. I am looking at the red one "e" significant operations located or conducted

across international borders where differing business environments and cultures exist.

- 847. Next red one, high vulnerability to rapid changes, such as changes in technology, product obsolescence, or interest rates.
- 848. The next one, significant operations located or conducted across International borders
- 849. where did it talk about that?
- 850. Was that like implied?
- 851. It was in there?
- 852. Oh, there it is I guess I missed it

#### **Participant 7**

- 971. I should have considered the nature of the industry more when I was going through it for the risk of fraud.
- 972. That I didn't consider at all,
- 973. but I should have considered the international borders
- 974. and how there is differing businesses
- 975. because they did say that they were a global firm,
- 976. global company
- 977. but I was looking at it
- 978. just wasn't looking at it from a global point of view.
- 979. I would have thought that the fixed assets was more of a

#### **Participant 11**

- 1226. the company's fixed assets...
- 1227. which is interesting because I kind of changed my answer regarding the fixed assets not being on the computer.
- 1228. I realized that although they are on paper
- 1229. there is not a fraud risk.
- 1230. Management labor indicated...
- 1231. fair enough.
- 1232. The company's patent...
- 1233. I would consider this still to be important,
- 1234. but not indicative of fraud
- 1235. They took additional debt or equity financing
- 1236. interesting I changed this one

### **4.4.3 Discussion of Results**

The overwhelming majority of operators stated by both of the condition groups was Action. This finding supports that participants' are making revisions to their assessments; which further supports that the expert system served as an aid to mitigate the dilution effect and as a learning tool. As evidenced in the verbal protocol report,

participants were re-thinking through their initial assessments and stating reasons to support their initial assessments and reasons to support their changes. They were not just conforming to the expert system. This finding further supports that the dilution effect can be mitigated with training and development through the use of the expert system. Information gathered via the expert system and through verbal protocol analysis can also help tailor training and development, so that the dilution effect disappears even without the expert system.

The relevant only information condition group made more inferences than queries and the opposite holds true for the relevant and irrelevant information condition group. Based on this finding, it appears participants are exercising more professional skepticism in the more complex situation (relevant and irrelevant information condition). Some research supports that professional skepticism decreases with experience (Grenier 2011; Payner and Ramsay 2005; Shaub and Lawrence 1999); however, less experienced auditors lack the overall experience, as well as industry specific experience, to disconfirm information. This leads to over auditing and more conservatism on the part of the less experienced auditors.

Regarding financial and non-financial related factors, there was a significant difference within condition groups regarding the total amount of non-financial verses financial related factors stated by participants. Both condition groups - relevant only information or relevant and irrelevant information - stated more non-financial related factors than financial related factors. There was also a significant difference between condition groups regarding the amount of non-financial and financial related factors stated by participants. The relevant only information condition group focused

significantly more on financial related factors than the relevant and irrelevant information condition group. The relevant and irrelevant information condition group focused more on non-financial related factors than the relevant only information condition group.

This finding supports that the dilution effect occurred because the non-financial operators stated by the participants were the irrelevant information cues. All irrelevant information factors were non-financial related and over-weighed by the participants in the relevant and irrelevant information condition group. The participants in this condition also under-weighed the financial related factors which were mostly relevant information cues.

In analyzing the initial verses final fraud risk assessments, it appears that both of the condition groups are learning from the expert system as based on the factors mentioned in making their final fraud risk assessment. The top three mentioned in the relevant only information condition were: debt, organization structure, and customers; and the top three mentioned in the relevant and irrelevant information condition were: global operations, competition, management integrity and industry.

In the relevant and irrelevant information condition group, participants mentioned most of the irrelevant information in making initial fraud risk assessments and abandoned them in making final fraud risk assessments. This was due to the process of the participants reviewing their individual factor assessments, as compared to the expert system's suggested range, and then re-reasoning through the factors. Participants were re-thinking through the significant risk factors and stating reasons why they initially under or over weighed those factors.

Overall, it appears that less experienced auditors mismatch the types of risks (i.e. business risks, audit risks, fraud risks). Most of the irrelevant information cues were risks, but not fraud risks. The participants properly recognized them as risks that should be considered in the audit; however before using the expert system they were improperly classifying them as fraud risk factors and overrating them, as compared to the actual fraud risk factors. After using the expert system they realized they incorrectly identified the type of risk and revised their fraud risk assessment.

#### **4.5 Conclusions**

This study investigated, in an experimental setting, the process of senior level auditors making fraud risk assessments both without and with the presence of the dilution effect. It was an extension of the Chapter 2 study, and applied verbal protocol analysis to further explain the results. The verbal protocol analysis was meant to provide further insight into the quantitative results. The goal of a protocol study is not to provide the right answer, just to offer a more detailed qualitative analysis to support the statistical results.

The results supported that the dilution effect did occur and then was mitigated with the use of the expert system. Based on the actual transcriptions and the coding of those transcriptions, it was shown that the irrelevant factors were mentioned in making initial assessments and then later disregarded in making the final assessments. Mostly because participants reasoned through the different risk factors when reviewing their overall assessments and then comparing them to the expert system. While only a few actually stated the rationale for change was based on the assessments of the expert system, it was evident from the transcriptions that the participants reasoned through areas

in which their assessments were out of range when compared to the expert system's range of assessments.

Future research can use verbal protocol analysis to develop a clean decision making template in an environment where judgment bias could be present. For example, comparing experienced auditors' (where the bias does not occur) to less experienced auditors' (where the bias does occur) decision making process in the presence of both relevant and irrelevant information. It would also be interesting to perform a study analyzing decision making with the focus on the International Financial Reporting Standards. These Standards require more principles-based than rules-based decision making. With this being implemented soon, changing from Generally Accepted Accounting Principles to International Financial Reporting Standards, many discrepancies in judgment may occur and it is important to analyze this and attempt to prevent as many issues as possible.

Further research is needed to determine why less experienced auditors are mismatching the types of risks (i.e. audit, business, fraud). Lastly, learning (retention), due to use of the expert system, can be studied over time by providing a different case (containing similar fraud risk factors), approximately two weeks apart to the same participants. The second time would not have the expert system available, and one could measure if participants make the same mistakes or learned and provided more appropriate assessments and rationales.

## **Chapter 5: Overall Conclusions, Limitations, and Future Research**

### **5.1 Overall Conclusions**

This dissertation set out to analyze the decision making process of less experienced auditors in the presence of specific judgment biases - the dilution effect and acceptability heuristic - that have been shown to be exacerbated in the presence of accountability. An expert system was developed to serve as a decision aid in the audit industry and used to mitigate these biases. This is a timely study because the accounting and auditing profession is in the process of adopting International Financial Reporting Standards ("IFRS"), which results in a shift from rules-based to principles-based accounting. Hence, auditors will need to apply more judgment in making decisions. These judgments made by auditors need to be both appropriate and effective because auditors may be held liable under federal securities laws or common laws. Also, there is an enhanced focus by regulators on the profession (i.e. PCAOB now conducts inspections of public accounting firms) and on professional skepticism. These factors make it essential for researchers to develop a way to mitigate judgment biases because mitigation of biases can lead to more efficient and effective auditing judgments, resulting in overall increased audit quality.

While previous studies have shown these biases exist (Hoffman and Patton 1997; Peytcheva and Gillett 2011), methods to significantly mitigate them with the use of technology have yet to be investigated. This dissertation demonstrates the successful development of AudEx, an expert system, which can be used in the audit industry. Use of this expert system as a decision aid for less experienced auditors resulted in more appropriate and effective assessments; which leads to overall increased audit quality.

The specific purpose of this dissertation was to experimentally examine if use of an expert system as a decision aid in developing auditor judgment can diminish auditor judgment biases. The two specific judgment biases examined were the dilution effect and the acceptability heuristic. Process tracing was also employed as a way to provide further insight into the dilution effect and the effects from using an expert system as a decision aid. Although prior research has examined both of these negative behavioral effects in relation to auditors' judgments (Hoffman and Patton 1997; Waller and Zimbelman 2003; Hackenbrack 1992), none have addressed mechanisms that either materially mitigate these biases or explored the role of technology to materially reduce this effect.

Decision aids are often suggested to mitigate auditor judgment biases (Hoffman and Patton 1997; Peytcheva and Gillett 2011). An expert system was chosen as the decision aid because previous researchers have shown that expert systems have a high level of accuracy (Bell *et al.* 1993; Eining *et al.* 1997; Eining and Jones 1997) and using an expert system as a decision aid will increase the appropriateness and effectiveness of the judgments made by less experienced auditors (Libby and Libby 1989; Gal and Steinbart 1987).

The specific expert system, AudEx, used in these studies was created and developed as a decision aid which can be used in the audit industry. It was necessary to create a system which was fully functioning, in regards to fraud risk assessments, and can be utilized in the audit industries. This system was designed to both capture and affect user behavior; examine the use of explanations, provided by the system, by less experienced auditors in a decision making environment; and require users to make complex judgments. A fully functioning system has been shown to influence novices'

and experts' judgments (Arnold *et al.* 2006). The majority of studies incorporating knowledge-based systems have not used a fully functional system, so most previous research was unable to engage the user or impact the behavior of the user (Gregor 2001).

Two individual laboratory experiments were conducted to examine the influence of the use of the expert system on the assessment and evaluation of an audit fraud risk scenario by audit seniors. One of the two experiments were used for two of the studies (Chapter 2 and Chapter 4). The case used in both experiments was obtained from Wilks and Zimbelman (2004) and modified for relevance to this dissertation. The case was validated by an expert panel of 20 audit managers and partners. Both judgment biases, dilution effect and acceptability heuristic, were tested individually in Chapters 2 and 3, respectively. Chapter 4 used a subset of participants from Chapter 2 and had those individual audit seniors think aloud in order to analyze individuals' thought processes involved in decision making and identify factors that led to overcoming the bias.

In all three essays, overall fraud risk assessments were compared to three separate benchmarks: Wilks and Zimbleman (2004), an expert panel of audit managers and partners, and the expert system. No significant differences were noted among any of the benchmarks (Table 2 and Table 8).

Overall results in the three essays supported that both biases did occur in the less experienced auditors and then were subsequently mitigated by the expert system, AudEx, resulting in lower fraud risk assessments. The last essay provided further insight into the dilution effect bias via the use of verbal protocol analysis (a method of process tracing) and uncovered that the less experienced auditors were mismatching types of risks.

### **5.1.1 Essay One: The Dilution Effect**

The dilution effect, the focus of Chapter 2, is a judgment bias in which irrelevant (i.e. nondiagnostic) cues, when processed along with relevant (i.e. diagnostic) cues causes an evaluator to under-weigh the relevant cues (Waller and Zimbelman 2003). In this study, a laboratory experiment was conducted to examine the influence of the use of the expert system, AudEx, on the assessment and evaluation of fraud risk by less experienced auditors. The dilution effect judgment bias was tested by employing a 2 (x 2) design. The dependent variable was auditor's final fraud risk assessment, as fraud risk assessments are commonly used among dilution effect studies (Hackenbrack 1992; Hoffman and Patton 1997). The two independent variables were expert system, manipulated within subjects, and relevance (relevant only information or relevant and irrelevant information), manipulated between subjects. The experiment consisted of 46 audit seniors from a regional public accounting firm averaging 4.2 years experience. This effect has been demonstrated to occur below audit manager level (Shelton 1999), so this chapter used audit seniors as participants. Before the experiment was conducted it was pilot tested with 40 graduate level auditing students.

The first proposed hypothesis stated that less experienced auditors will make lower fraud risk assessments when using the expert system as compared to not using the expert system. It was tested by comparing means of the overall fraud risk assessments of participants with and without the use of expert systems to manager and partner assessments, as well as within both condition groups. Results of the experiment supported that the less experienced auditors produced a lower overall fraud risk assessment, closer to the experienced auditors, with no significant variances (Table 3), with use of the expert system. Results also supported that less experienced auditors in

both condition groups produced lower fraud risk assessments with the use of the expert system than without the use of the expert system. The participants' fraud risk assessments in the relevant only condition were not significantly lower from no use to use of the expert system, which was expected because there was not irrelevant information present; however, the participants in the relevant and irrelevant information condition did have a significantly lower fraud risk assessment with the use of the expert system.

The second hypothesis suggested that using an expert system as a decision aid reduces the dilution effect exhibited by less experienced auditors. A mixed model analysis of variance with repeated measures was conducted to assess the impact of the expert system on participants' fraud risk assessments across two time periods. In looking at the interaction effect between time and expert system use, there was a statistically significant effect. These findings suggested that the auditors who made assessments on their own without use of the expert system were significantly influenced by irrelevant information, unlike when auditors had use of the expert system and the dilution effect was mitigated (Table 5). Hence, the interaction statistics show that the use of the expert system has a significant effect on fraud risk assessments.

### **5.1.2 Essay Two: The Acceptability Heuristic**

The acceptability heuristic, the focus of Chapter 3, creates a shifting towards the preferences of another and adopting a position that is deemed socially acceptable (Tetlock *et al.* 1989). A 2 (x 2) laboratory experiment was conducted to examine the influence of the use of the expert system, AudEx, on the assessment of fraud risk in counteracting the acceptability heuristic bias. The dependent variable was audit senior final fraud risk assessment. The independent variables were learning audit partners' views, manipulated within conditions, and expert system (no use of expert system or use

of expert system), manipulated between conditions. The experiment consisted of 44 audit seniors from a regional public accounting firm averaging 4.09 years of experience. Prior studies have shown less experienced auditors, who are aware of the views of audit partners', modify their judgments to agree with that of the partners' when being held accountable to superiors (Koonce *et al.* 1995; Peecher 1996; Peytcheva and Gillett 2011).

The first hypothesis stated that less experienced auditors who learn partners' views after they have made a judgment themselves alter their original judgment, aligning it with partners' views. Results supported that the audit seniors in the group without the use of the expert system did align their assessments with that of the audit partners. The mean from the expert panel of audit managers and partners was compared to the fraud risk assessments from both groups, without and with the use of the expert system (Table 9). These results were also supported with a mixed model analysis of variance (Table 10) by showing that there is no significant difference in the means between conditions before learning partners' views; however, there is a significant variation in the means between conditions after learning partners' views.

The second hypothesis was that using an expert system as a decision aid reduces the acceptability heuristic bias exhibited by less experienced auditors who learn the audit partners' views. This hypothesis was also supported by the results of the experiment and was tested with a mixed model analysis of variance. The results from the between-subjects analysis (Table 13) support that there was no significant variation between the means of the initial assessments between no use of expert system and use of expert system condition groups; however, there was a significant variation between the final assessments of no use of expert system and use of expert system groups.

Use of the expert system mitigated the acceptability heuristic in the condition with use of the expert system as the final assessment was significantly different from the condition without use of the expert system. These findings suggested that the auditors who made assessments with the availability of the expert system were not significantly influenced by learning audit partners' views, unlike the case for the auditors who did not use the expert system. These results demonstrated that the expert system AudEx successfully mitigated the judgment bias.

Table 11 also contains the within-subjects analysis demonstrating a significant difference between the initial and final assessments in the no expert system group, which was due to the acceptability heuristic bias occurring after learning the audit partners' views. There was not a significant variation between the initial and final assessments in the group with the use of the expert system, supporting the second hypothesis that the expert system mitigated the acceptability heuristic bias.

### **5.1.3 Essay Three: Verbal Protocol Analysis and the Dilution Effect**

The third experimental study, evidenced in Chapter 4, adopted the dilution effect experiment from the first essay. The following additions were made to the experiment for the purpose of this study: (1) conducted for each participant individually and (2) participants were asked to think aloud throughout the entire experiment. The purpose of this chapter was to provide further insight into the decision making process of less experienced auditors in an environment without and with the dilution effect present, as well as the effects from using the expert system AudEx as a decision aid.

This study was an extension of Chapter 2, and applied verbal protocol analysis. The verbal protocol analysis was meant to provide further insight into the quantitative results. The results supported that the dilution effect did occur and then was mitigated

with the use of the expert system. Results were analyzed both quantitatively and qualitatively for completeness. Participants consisted of 12 audit seniors from a public accounting firm and were a subset (26%) from the 46 participants used in Chapter 2 however, they were the only 12 to think aloud during the experiment. The dependent and independent variables were the same as in Chapter 2.

Based on the transcriptions and the coding of those transcriptions, it was shown that the irrelevant factors were mentioned in making initial assessments and then later disregarded in making the final assessments. Mostly because participants reasoned through the different risk factors when reviewing their overall assessments and comparing to the expert system. It was not just a matter of conforming to the system because they were actually re-thinking through the significant fraud risk factors and stating reasons why they initially under or over weighed them in making the initial fraud risk assessment. While only a few actually stated the rationale for change was based on the assessments of the expert system, it was evident from the transcriptions that the participants reasoned through areas in which their assessments were out of range when compared to the expert system's range of assessments.

The transcriptions also revealed that participants were correctly identifying risk factors; however, they were incorrectly classifying the risks as fraud risk factors, as opposed to business or audit risk factors. It appears less experienced auditors are mismatching risks (i.e. business risks, audit risks, and fraud risks). Most of the irrelevant factors were risk factors; however, they were not fraud risk factors. The audit seniors did realize that they were important factors that should be considered in the audit, but before using the expert system they were identifying them as fraud risk factors and overrating

them as compared to the actual fraud risk factors. The expert system did assist in the audit seniors' realization of incorrectly identifying the type of risk, as evidenced in the transcripts relating to the rationale for assessment of the final fraud risk factor.

## **5.2 Limitations**

The experiments in this dissertation contained the general limitations associated with experimental research. The generalizability of their conclusions could be limited, as the experiments did not involve actual fieldwork. To insure reliability of audit partners' views, rationales were included so participants had justification for the partners' assessments.

Process tracing has increased in popularity, but is not without its criticisms and limitations. One critique is regarding the variability in how process tracing is employed and its difficulty in delineating boundaries of this methodology (Patrick and James 2004). Woods (1992) distinguishes two main process tracing methods: verbal reports and behavioral protocols. These alone do not represent complete methodologies, so researchers can refer to how data are collected, coded, structured, and represented to counteract this criticism (Woods 1992). Another criticism is the lack of description of the procedures used to infer underlying cognitive processes and data acquisition methods (Blackman and Nelson 1988; Doherty 1993). Again, this critique can be avoided by providing these details in the write-up of one's study.

If accounting firms were properly informed and trained on expert systems and the value of utilizing them as a decision aid, more appropriate assessments could be made and the potential for reduced time and cost savings could be presented as audit quality would be increased. If auditors were to spend less time employing their judgment in evaluating and assessing initial data, they could spend more time in performing

procedures, employing judgment in other significant areas of the audit, and focusing on the business environment of the client.

### **5.3 Future Research**

Future research can examine the impact of expert systems as decision aids on International Financial Reporting Standards, since the transition will be made from rules-based accounting to principles-based accounting (i.e. intangibles, revenue recognition, leases). Also, research can be performed to determine if an over-reliance on expert systems develops. Specifically, if there are factors an expert system cannot account for, will auditors still rely on the system? Verbal protocol analysis can be used to provide further insight into the acceptability heuristic by replicating Chapter 3. Researchers can also use verbal protocol analysis to examine the difference between less experienced auditors and experienced auditors and create a clean decision making template free of judgment bias (from the experienced auditors).

Further research is needed to determine why less experienced auditors are mismatching the types of risks (i.e. audit, business, fraud). Lastly, learning (retention), due to use of the expert system, over time can be studied by providing a different case, but with the same fraud risk factors in it, approximately two weeks apart to the same participants. The second time would not have the expert system available, and one could measure if participants make the same mistakes or learned and provided more appropriate assessments and rationales.

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## Appendix A: Dilution Effect Case and Instruments

### A.1 Fraud Risk Assessment Case: Dilution Effect - Version One

#### Version 1: With the use of an expert system AND with relevant only information

##### **Oltrak, Inc.**

##### *Company Background*

Oltrak, Inc. (a publicly traded company) is one of the leading global electronic security companies in the world. Oltrak designs, manufactures, markets, sells and services innovative electronic products and systems for security and surveillance, industrial video and professional audio markets worldwide. These products and systems include video monitors, switchers, quad processors, digital and analog recorders, multiplexers, video transmission systems, cameras, lenses, observation systems, audio equipment and accessories. Customers range from single location mom-and-pop businesses to universities and government facilities. Sales to the professional security markets are through the Company's channel partners. The Company has increased sales from \$1.8 million to \$210 million over the last 20 years.

The following financial data have been derived from the consolidated financial statements of the Company and its subsidiaries.

	<b>20x6</b>	<b>20x7</b>	<b>20x8</b>	<b>20x9</b>	<b>20x0</b>
<b>Net sales [in thousands]</b>	\$148,977	\$177,837	\$196,998	\$208,200	\$209,998
<b>Net income (loss)</b>	1,599	2,401	3,555	3,865	2,972
<b>Total assets</b>	172,510	185,256	196,626	200,350	193,497

##### *Industry/Competition*

The Company faces substantial competition in each of its markets. Significant competitive factors in the Company's markets include price, quality and product performance, breadth of product line and customer service and support. Some of the Company's existing and potential competitors have substantially greater financial, manufacturing, marketing and other resources than the Company. To compete successfully, the Company must continue to make substantial investments in its engineering and development, marketing, sales, customer service and support activities.

The Company considers its major competitors to be the CCTV and access control operations of Sensormatic Electronics Corporation, Burle (part of Philips Communication & Security Systems, Inc.), Panasonic, Pelco, Lenel, and Interlogics.

***Management Background***

The management team of Oltrak is made up of the following key individuals:

President and CEO, George Schultz  
Vice President of Sales and Marketing, Tammy Miller  
Vice President of Operations, Chris Streeter  
Chief Financial Officer, Theo Smith  
Controller, Fred Beck

Most of the management team has been with Oltrak since the current audit firm began auditing the company eight years ago. Over the years, the management team has been very easy to work with and shown a high level of competence. Furthermore, several sources of information indicate that the character of the management team is of a high quality. For example, the partner in charge of this audit has told you that the integrity of upper management is impeccable. He also commented to you that the CEO is one of the most honorable businessmen in the community and that he admires his leadership in the local community service organizations such as the United Way. Most people in the business community characterize Oltrak as being very supportive of community values and high ideals. This characterization stems largely from the high ideals of the management team.

***Additional Information***

- The company may have marginal ability to meet debt repayment requirements
- Significant declines in customer demand and increasing business failures have been prevalent in the industry and overall economy.

Now, consider the overall risk of material financial statement fraud, and answer the following question:

Based on all the information you have reviewed on Oltrak, Inc., what is the overall risk of material financial statement fraud for this company?

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

Based on the background information provided for Oltrak, Inc., please note if the following factors were considered in making your fraud risk assessment of Oltrak, Inc. If not considered, please select "0-did not consider"; otherwise, rate from 1 (extremely unimportant) to 7 (extremely important) how important each one is making a fraud risk assessment.

- a. High degree of competition or market saturation, accompanied by declining margins.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- b. The company may have marginal ability to meet debt repayment requirements

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- c. Due to the nature of the industry, the company has high vulnerability to rapid changes, such as changes in technology, product obsolescence, or interest rates.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- d. Significant declines in customer demand and increasing business failures have been prevalent in the industry and overall economy.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- e. Significant operations located or conducted across international borders where differing business environments and cultures exist.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- f. There is a need to obtain additional debt or equity financing to stay competitive-including financing of major research and development or capital expenditures.

\_\_\_\_\_ Did not consider

\_\_\_\_\_ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- g. Other factors considered, if any, list and rate from 1 (extremely unimportant) to 7 (extremely important):

### The Expert System

Based on the background information provided for Oltrak Inc., please note if the following factors were present for Oltrak, Inc. If not present, please select "0-not present". Otherwise, please rate from 1 (extremely unimportant) to 7 (extremely important) how important each one is in making a fraud risk assessment.

- Domineering management behavior displayed in dealing with the auditor, especially involving attempts to influence the scope of the auditor's work.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Unusual rapid growth or profitability, especially compared with that of other companies in the same industry.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Excessive interest by management in maintaining or increasing the entity's stock price or earnings trend.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Frequent disputes with the current or predecessor auditor on accounting, auditing, or reporting matters.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Lack of monitoring of controls, including automated controls and controls over interim financial reporting (where external reporting is required).

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Difficulty in determining the organization or individual(s) that control(s) the entity.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Formal or informal restrictions on the auditor that inappropriately limit access to people or information or the ability to communicate effectively with the board of directors or audit committee.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- High degree of competition or market saturation, accompanied by declining margins.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Operating losses making the threat of bankruptcy, foreclosure, or hostile takeover imminent.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Recurring negative cash flows from operations or an inability to generate cash flows from operations while reporting earnings and earnings growth.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Marginal ability to meet debt repayment or other debt covenant requirements.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- High vulnerability to rapid changes, such as changes in technology, product obsolescence, or interest rates.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Significant declines in customer demand and increasing business failures in either the industry or overall economy.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Significant operations located or conducted across international borders where differing business environments and cultures exist.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Need to obtain additional debt or equity financing to stay competitive-including financing of major research and development or capital expenditures.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- High turnover of senior management, counsel, or board members.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

**EXPERT SYSTEM REPORT<sup>21</sup>**

<b>Deviation</b>	<b>Your response</b>	<b>System response</b>
Domineering management behavior displayed in dealing with the auditor, especially involving attempts to influence the scope of the auditor's work +1	<b>X</b>	<b>Y</b>
Unusual rapid growth or profitability, especially compared with that of other companies in the same industry None	<b>Z</b>	<b>Z</b>
.		
.		
.		

---

**Your initial fraud risk assessment was X**

Given this feedback, would you like to change your assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

☐ No  
☐ Yes

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

Please explain/justify why you have (have not) changed your assessment for the overall risk of material financial statement fraud for Oltrak, Inc..

Your final financial statement fraud risk assessment for Oltrak, Inc. was **Y (from right above)** and the recommended assessment is **Y**.

---

<sup>21</sup> Note, in the actual experiment this report included all questions by the participants.

### Post-experiment Questionnaire

1. How many times within the last three years have you evaluated the risk of fraudulent activity on a client?

0      1      2      3      4      5      6      7      other:\_\_\_\_\_

2. How many times have you encountered fraudulent activity on a client?

0      1      2      3      4      5      6      7      other:\_\_\_\_\_

Please explain the situation (keeping the Company and Employees anonymous).

3. How many times have you used an expert system in the context of an audit?

0      1      2      3      4      5      6      7      other\_\_\_\_\_

If yes, please explain:

4. How important do you think the expert system was that you used in making an assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

5. Did you encounter any problems while working with this expert system? If yes, please explain.
6. What would you add to or delete from this expert system you used in making an assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

7. How prevalent do you think the following three elements of the fraud triangle were in Oltrak, Inc.?

a. Management has strong attitude/rationale to commit fraud

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

b. Management has opportunity to commit fraud

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

c. Management has incentives/pressures to commit fraud

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

8. Do you feel that you were given enough information to make an assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

1	2	3	4	5	6	7
Extremely less than needed	Less than needed	Slightly Less than needed	Just enough	Slightly more than needed	More than needed	Extremely more than needed

9. How confident are you in your assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

1	2	3	4	5	6	7
Extremely unconfident	Very unconfident	Somewhat unconfident	Neutral	Somewhat confident	Very confident	Extremely confident

10. Did you find assessing the overall risk of material financial statement fraud for Oltrak, Inc. to be:

1	2	3	4	5	6	7
Extremely easy	Very easy	Somewhat easy	Moderate	Somewhat difficult	Very difficult	Extremely difficult

11. Please express any other comments you wish here.

Gender: Male    Female

Highest degree obtained: A.S./A.A.    B.S./B.A.    M.S./M.A.  
    MPA/MSA    MBA    Ph.D.    Other \_\_\_\_\_

Professional Designation: CPA    CIA    CMA    CFA  
    CFE    EA    CGFM    Other \_\_\_\_\_

Years of professional working experience: \_\_\_\_\_ Present  
 position: \_\_\_\_\_

Are you with the same public accounting firm you started your career with? Yes    No

If not, which type of firm did you start with? Big 4    National    Regional  
    Other \_\_\_\_\_

How many years were you employed with this first firm? \_\_\_\_\_

Have you worked at any other firms in between your starting and present firm? Yes  
    No

If yes, which types of firms and for how long did you work at each firm? Please list in  
 chronological order.

\_\_\_\_\_

PLEASE DO NOT DISCUSS THIS EXPERIMENT WITH ANYONE WHO WILL OR  
 MIGHT BE PARTICIPATING. THANK YOU VERY MUCH FOR YOUR TIME AND  
 PARTICIPATION.

## A.2 Fraud Risk Assessment Case: Dilution Effect - Version Two

### Version 2: With the use of an expert system AND with relevant and irrelevant information

#### Oltrak, Inc.

##### *Company Background*

Oltrak, Inc. (a publicly traded company) is one of the leading global electronic security companies in the world. Oltrak designs, manufactures, markets, sells and services innovative electronic products and systems for security and surveillance, industrial video and professional audio markets worldwide. These products and systems include video monitors, switchers, quad processors, digital and analog recorders, multiplexers, video transmission systems, cameras, lenses, observation systems, audio equipment and accessories. Customers range from single location mom-and-pop businesses to universities and government facilities. Sales to the professional security markets are through the Company's channel partners. The Company has increased sales from \$1.8 million to \$210 million over the last 20 years.

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	<b>20x6</b>	<b>20x7</b>	<b>20x8</b>	<b>20x9</b>	<b>20x0</b>
<b>Net sales [in thousands]</b>	\$148,977	\$177,837	\$196,998	\$208,200	\$209,998
<b>Net income (loss)</b>	1,599	2,401	3,555	3,865	2,972
<b>Total assets</b>	172,510	185,256	196,626	200,350	193,497

##### *Industry/Competition*

The Company faces substantial competition in each of its markets. Significant competitive factors in the Company's markets include price, quality and product performance, breadth of product line and customer service and support. Some of the Company's existing and potential competitors have substantially greater financial, manufacturing, marketing and other resources than the Company. To compete successfully, the Company must continue to make substantial investments in its engineering and development, marketing, sales, customer service and support activities.

The Company considers its major competitors to be the CCTV and access control operations of Sensormatic Electronics Corporation, Burle (part of Philips Communication & Security Systems, Inc.), Panasonic, Pelco, Lenel, and Interlogics.

### ***Management Background***

The management team of Oltrak is made up of the following key individuals:

President and CEO, George Schultz  
Vice President of Sales and Marketing, Tammy Miller  
Vice President of Operations, Chris Streeter  
Chief Financial Officer, Theo Smith  
Controller, Fred Beck

Most of the management team has been with Oltrak since the current audit firm began auditing the company eight years ago. Over the years, the management team has been very easy to work with and shown a high level of competence. Furthermore, several sources of information indicate that the character of the management team is of a high quality. For example, the partner in charge of this audit has told you that the integrity of upper management is impeccable. He also commented to you that the CEO is one of the most honorable businessmen in the community and that he admires his leadership in the local community service organizations such as the United Way. Most people in the business community characterize Oltrak as being very supportive of community values and high ideals. This characterization stems largely from the high ideals of the management team.

### ***Additional Information***

- The company may have marginal ability to meet debt repayment requirements
- Significant declines in customer demand and increasing business failures have been prevalent in the industry and overall economy.
- Due to dissatisfaction with the quality and level of service that it was receiving, the company switched advertising agencies.
- The company's fixed asset and depreciation records are maintained manually, not on the computer.
- Management and labor representatives indicate that there is a possibility of a strike in the coming year.
- The company's patent on a unique product feature has expired.

Now, consider the overall risk of material financial statement fraud, and answer the following question:

Based on all the information you have reviewed on Oltrak, Inc., what is the overall risk of material financial statement fraud for this company?

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

Based on the background information provided for Oltrak, Inc., please note if the following factors were considered in making your fraud risk assessment of Oltrak, Inc. If not considered, select "0-did not consider". Otherwise, rate from 1 (extremely unimportant) to 7 (extremely important) how important each one is making a fraud risk assessment.

- a. High degree of competition or market saturation, accompanied by declining margins.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- b. The company may have marginal ability to meet debt repayment requirements

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- c. Due to the nature of the industry, the company has high vulnerability to rapid changes, such as changes in technology, product obsolescence, or interest rates.

\_\_\_ Did not consider

\_\_\_ Did consider

1	2	3	4	5	6	7
Extremely Unimportant		Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important
	Very Unimportant					

- d. Significant declines in customer demand and increasing business failures have been prevalent in the industry and overall economy.

\_\_\_ Did not consider

\_\_\_ Did consider

1	2	3	4	5	6	7
Extremely Unimportant		Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important
	Very Unimportant					

- e. Significant operations located or conducted across international borders where differing business environments and cultures exist.

\_\_\_ Did not consider

\_\_\_ Did consider

1	2	3	4	5	6	7
Extremely Unimportant		Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important
	Very Unimportant					

- f. There is a need to obtain additional debt or equity financing to stay competitive-including financing of major research and development or capital expenditures.

\_\_\_\_\_ Did not consider

\_\_\_\_\_ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- g. Due to dissatisfaction with the quality and level of service that it was receiving, the company switched advertising agencies.

\_\_\_\_\_ Did not consider

\_\_\_\_\_ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- h. The company's fixed asset and depreciation records are maintained manually, not on the computer.

\_\_\_\_ Did not consider  
 \_\_\_\_ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- i. Management and labor representatives indicate that there is a possibility of a strike in the coming year.

\_\_\_\_ Did not consider  
 \_\_\_\_ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- j. The company's patent on a unique product feature has expired.

\_\_\_\_ Did not consider  
 \_\_\_\_ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- k. Other factors (list and rate from 1 (extremely unimportant) to 7 (extremely important), if any):

### The Expert System

Based on the background information provided for Oltrak Inc., please note if the following factors were present for Oltrak, Inc. If not present, please select "0-not present". Otherwise, please rate from 1 (extremely unimportant) to 7 (extremely important) how important each one is in making a fraud risk assessment.

- Domineering management behavior displayed in dealing with the auditor, especially involving attempts to influence the scope of the auditor's work.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Unusual rapid growth or profitability, especially compared with that of other companies in the same industry.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Excessive interest by management in maintaining or increasing the entity's stock price or earnings trend.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Frequent disputes with the current or predecessor auditor on accounting, auditing, or reporting matters.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Lack of monitoring of controls, including automated controls and controls over interim financial reporting (where external reporting is required).

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Difficulty in determining the organization or individual(s) that control(s) the entity.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Formal or informal restrictions on the auditor that inappropriately limit access to people or information or the ability to communicate effectively with the board of directors or audit committee.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- High degree of competition or market saturation, accompanied by declining margins.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Operating losses making the threat of bankruptcy, foreclosure, or hostile takeover imminent.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Recurring negative cash flows from operations or an inability to generate cash flows from operations while reporting earnings and earnings growth.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Marginal ability to meet debt repayment or other debt covenant requirements.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- High vulnerability to rapid changes, such as changes in technology, product obsolescence, or interest rates.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Significant declines in customer demand and increasing business failures in either the industry or overall economy.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Significant operations located or conducted across international borders where differing business environments and cultures exist.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Need to obtain additional debt or equity financing to stay competitive-including financing of major research and development or capital expenditures.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- High turnover of senior management, counsel, or board members.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

**EXPERT SYSTEM REPORT<sup>22</sup>**

<b>Deviation</b>	<b>Your response</b>	<b>System response</b>
Domineering management behavior displayed in dealing with the auditor, especially involving attempts to influence the scope of the auditor's work +1	<b>X</b>	<b>Y</b>
Unusual rapid growth or profitability, especially compared with that of other companies in the same industry None	<b>Z</b>	<b>Z</b>
.		
.		
.		

**Your initial fraud risk assessment was X**

Given this feedback, would you like to change your assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

\_\_\_\_\_ No

\_\_\_\_\_ Yes

	1	2	3	4	5	6	7
Extremely Low							
Very Low							
Somewhat Low							
Moderate							
Somewhat High							
Very High							
Extremely High							

Please explain/justify why you have (have not) changed your assessment for the overall risk of material financial statement fraud for Oltrak, Inc..

Your final financial statement fraud risk assessment for Oltrak, Inc. was **Y (from right above)** and the recommended assessment is **Y**.

<sup>22</sup> Note this report includes all questions assessed in the experiment.

Post-experiment Questionnaire

1. How many times within the last three years have you evaluated the risk of fraudulent activity on a client?

0      1      2      3      4      5      6      7      other:\_\_\_\_\_

2. How many times have you encountered fraudulent activity on a client?

0      1      2      3      4      5      6      7      other:\_\_\_\_\_

Please explain the situation (keeping the Company and Employees anonymous).

3. How many times have you used an expert system in the context of an audit?

0      1      2      3      4      5      6      7      other\_\_\_\_\_

If yes, please explain:

4. How important do you think the expert system was that you used in making an assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

5. Did you encounter any problems while working with this expert system? If yes, please explain.

6. What would you add to or delete from this expert system you used in making an assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

7. How prevalent do you think the following three elements of the fraud triangle were in Oltrak, Inc.?

d. Management has strong attitude/rationale to commit fraud

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

e. Management has opportunity to commit fraud

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

f. Management has incentives/pressures to commit fraud

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

8. Do you feel that you were given enough information to make an assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

1	2	3	4	5	6	7
Extremely less than needed	Less than needed	Slightly Less than needed	Just enough	Slightly more than needed	More than needed	Extremely more than needed

9. How confident are you in your assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

1	2	3	4	5	6	7
Extremely unconfident	Very unconfident	Somewhat unconfident	Neutral	Somewhat confident	Very confident	Extremely confident

10. Did you find assessing the overall risk of material financial statement fraud for Oltrak, Inc. to be:

1	2	3	4	5	6	7
Extremely easy	Very easy	Somewhat easy	Moderate	Somewhat difficult	Very difficult	Extremely difficult

11. Please express any other comments you wish here.

Gender: Male    Female

Highest degree obtained: A.S./A.A.    B.S./B.A.    M.S./M.A.  
    MPA/MSA    MBA    Ph.D.    Other \_\_\_\_\_

Professional Designation: CPA    CIA    CMA    CFA  
    CFE    EA    CGFM    Other \_\_\_\_\_

Years of professional working experience: \_\_\_\_\_ Present  
 position: \_\_\_\_\_

Are you with the same public accounting firm you started your career with? Yes    No

If not, which type of firm did you start with? Big 4    National    Regional  
    Other \_\_\_\_\_

How many years were you employed with this first firm? \_\_\_\_\_

Have you worked at any other firms in between your starting and present firm? Yes  
    No

If yes, which types of firms and for how long did you work at each firm? Please list in chronological order.

PLEASE DO NOT DISCUSS THIS EXPERIMENT WITH ANYONE WHO WILL OR MIGHT BE PARTICIPATING. THANK YOU VERY MUCH FOR YOUR TIME AND PARTICIPATION.

## Appendix B: Acceptability Heuristic Case and Instruments

### B.1 Fraud Risk Assessment Case: Acceptability Heuristic - Version One

#### Version 1: Without the use of an expert system AND with learning partners' views

##### Oltrak, Inc.

##### *Company Background*

Oltrak, Inc. (a publicly traded company) is one of the leading global electronic security companies in the world. Oltrak designs, manufactures, markets, sells and services innovative electronic products and systems for security and surveillance, industrial video and professional audio markets worldwide. These products and systems include video monitors, switchers, quad processors, digital and analog recorders, multiplexers, video transmission systems, cameras, lenses, observation systems, audio equipment and accessories. Customers range from single location mom-and-pop businesses to universities and government facilities. Sales to the professional security markets are through the Company's channel partners. The Company has increased sales from \$1.8 million to \$210 million over the last 20 years.

The following financial data have been derived from the consolidated financial statements of the Company and its subsidiaries.

	<b>20x6</b>	<b>20x7</b>	<b>20x8</b>	<b>20x9</b>	<b>20x0</b>
<b>Net sales [in thousands]</b>	\$148,977	\$177,837	\$196,998	\$208,200	\$209,998
<b>Net income (loss)</b>	1,599	2,401	3,555	3,865	2,972
<b>Total assets</b>	172,510	185,256	196,626	200,350	193,497

##### *Industry/Competition*

The Company faces substantial competition in each of its markets. Significant competitive factors in the Company's markets include price, quality and product performance, breadth of product line and customer service and support. Some of the Company's existing and potential competitors have substantially greater financial, manufacturing, marketing and other resources than the Company. To compete successfully, the Company must continue to make substantial investments in its engineering and development, marketing, sales, customer service and support activities.

The Company considers its major competitors to be the CCTV and access control operations of Sensormatic Electronics Corporation, Burle (part of Philips Communication & Security Systems, Inc.), Panasonic, Pelco, Lenel, and Interlogics.

***Management Background***

The management team of Oltrak is made up of the following key individuals:

President and CEO, George Schultz  
Vice President of Sales and Marketing, Tammy Miller  
Vice President of Operations, Chris Streeter  
Chief Financial Officer, Theo Smith  
Controller, Fred Beck

Most of the management team has been with Oltrak since the current audit firm began auditing the company eight years ago. Over the years, the management team has been very easy to work with and shown a high level of competence. Furthermore, several sources of information indicate that the character of the management team is of a high quality. For example, the partner in charge of this audit has told you that the integrity of upper management is impeccable. He also commented to you that the CEO is one of the most honorable businessmen in the community and that he admires his leadership in the local community service organizations such as the United Way. Most people in the business community characterize Oltrak as being very supportive of community values and high ideals. This characterization stems largely from the high ideals of the management team.

***Additional Information***

- The company may have marginal ability to meet debt repayment requirements
- Significant declines in customer demand and increasing business failures have been prevalent in the industry and overall economy.

Now, consider the overall risk of material financial statement fraud, and answer the following question:

Based on all the information you have reviewed on Oltrak, Inc., what is the overall risk of material financial statement fraud for this company?

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

Based on the background information provided for Oltrak, Inc., please note if the following factors were considered in making your fraud risk assessment of Oltrak, Inc. If not considered, please select "0-did not consider". Otherwise, rate from 1 (extremely unimportant) to 7 (extremely important) how important each one is making a fraud risk assessment.

- a. High degree of competition or market saturation, accompanied by declining margins.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- b. The company may have marginal ability to meet debt repayment requirements

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- c. Due to the nature of the industry, the company has high vulnerability to rapid changes, such as changes in technology, product obsolescence, or interest rates.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- d. Significant declines in customer demand and increasing business failures have been prevalent in the industry and overall economy.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- e. Significant operations located or conducted across international borders where differing business environments and cultures exist.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- f. There is a need to obtain additional debt or equity financing to stay competitive-including financing of major research and development or capital expenditures.

\_\_\_\_\_ Did not consider

\_\_\_\_\_ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- g. Other factors considered, if any, list and rate from 1 (extremely unimportant) to 7 (extremely important):

The **audit partner's assessment** is that the risk of fraud is very high. This assessment is based on the following information:

The company has had the same auditors for 8 years. Since they have gained this very positive personal relationship with management they may not be as objective with their testing and be too trusting of what management tells them.

There community support could be used to overshadow there fraudulent ways.

The company appears to be under pressure to meet customer demands as several competitors have substantially greater financial, manufacturing, marketing and other resources than the Company. To compete successfully, the Company must continue to make substantial investments in its engineering and development, marketing, sales, customer service and support activities. That gives them incentive to cheat.

Sales have increased greatly over the last 20 years (last 5 of those 20 as well) even though there have been significant declines in customer demand and increasing business failures are occurring.

Given this feedback, would you like to change your assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

☐ No  
☐ Yes

	1	2	3	4	5	6	7
	Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

Please explain/justify why you have (have not) changed your assessment for the overall risk of material financial statement fraud for Oltrak, Inc..

Post-experiment Questionnaire

1. How many times within the last three years have you evaluated the risk of fraudulent activity on a client?

0      1      2      3      4      5      6      7      other:\_\_\_\_\_

2. How many times have you encountered fraudulent activity on a client?

0      1      2      3      4      5      6      7      other:\_\_\_\_\_

Please explain the situation (keeping the Company and Employees anonymous).

3. How many times have you used an expert system in the context of an audit?

0      1      2      3      4      5      6      7      other\_\_\_\_\_

If yes, please explain:

4. How prevalent do you think the following three elements of the fraud triangle were in Oltrak, Inc.?

g. Management has strong attitude/rationale to commit fraud

1                  2                  3                  4                  5                  6                  7

Extremely Low

Very Low

Somewhat Low

Moderate

Somewhat High

Very High

Extremely High

h. Management has opportunity to commit fraud

1                  2                  3                  4                  5                  6                  7

Extremely Low

Very Low

Somewhat Low

Moderate

Somewhat High

Very High

Extremely High

i. Management has incentives/pressures to commit fraud

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

5. Do you feel that you were given enough information to make an assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

1	2	3	4	5	6	7
Extremely less than needed	Less than needed	Slightly Less than needed	Just enough	Slightly more than needed	More than needed	Extremely more than needed

6. How confident are you in your assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

1	2	3	4	5	6	7
Extremely unconfident	Very unconfident	Somewhat unconfident	Neutral	Somewhat confident	Very confident	Extremely confident

7. Did you find assessing the overall risk of material financial statement fraud for Oltrak, Inc. to be:

1	2	3	4	5	6	7
Extremely easy	Very easy	Somewhat easy	Moderate	Somewhat difficult	Very difficult	Extremely difficult

8. Please express any other comments you wish here.

Manipulation Checks (for all groups)

1) Did you learn the partners' assessment of fraud risk?

Check one of the following: \_\_\_\_Yes \_\_\_\_No

If you answered yes, what was the partners' assessment of the fraud risk?

	1	2	3	4	5	6	7
	Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

Gender: Male    Female

Highest degree obtained: A.S./A.A.                      B.S./B.A.                      M.S./M.A.  
    MPA/MSA                      MBA                      Ph.D.                      Other \_\_\_\_\_

Professional Designation:    CPA                      CIA                      CMA                      CFA  
    CFE    EA                      CGFM                      Other \_\_\_\_\_

Years of professional working experience: \_\_\_\_\_    Present  
 position: \_\_\_\_\_

Are you with the same public accounting firm you started your career with? Yes    No

If not, which type of firm did you start with?    Big 4                      National                      Regional  
    Other \_\_\_\_\_

How many years were you employed with this first firm? \_\_\_\_\_

Have you worked at any other firms in between your starting and present firm?    Yes  
    No

If yes, which types of firms and for how long did you work at each firm? Please list in  
 chronological order. \_\_\_\_\_

PLEASE DO NOT DISCUSS THIS EXPERIMENT WITH ANYONE WHO WILL OR  
 MIGHT BE PARTICIPATING. THANK YOU VERY MUCH FOR YOUR TIME AND  
 PARTICIPATION.

## B.2 Fraud Risk Assessment Case: Acceptability Heuristic - Version Two

### Version 2: With the use of an expert system AND with learning partners' views

#### Oltrak, Inc.

##### *Company Background*

Oltrak, Inc. (a publicly traded company) is one of the leading global electronic security companies in the world. Oltrak designs, manufactures, markets, sells and services innovative electronic products and systems for security and surveillance, industrial video and professional audio markets worldwide. These products and systems include video monitors, switchers, quad processors, digital and analog recorders, multiplexers, video transmission systems, cameras, lenses, observation systems, audio equipment and accessories. Customers range from single location mom-and-pop businesses to universities and government facilities. Sales to the professional security markets are through the Company's channel partners. The Company has increased sales from \$1.8 million to \$210 million over the last 20 years.

The following financial data have been derived from the consolidated financial statements of the Company and its subsidiaries.

	<b>20x6</b>	<b>20x7</b>	<b>20x8</b>	<b>20x9</b>	<b>20x0</b>
<b>Net sales [in thousands]</b>	\$148,977	\$177,837	\$196,998	\$208,200	\$209,998
<b>Net income (loss)</b>	1,599	2,401	3,555	3,865	2,972
<b>Total assets</b>	172,510	185,256	196,626	200,350	193,497

##### *Industry/Competition*

The Company faces substantial competition in each of its markets. Significant competitive factors in the Company's markets include price, quality and product performance, breadth of product line and customer service and support. Some of the Company's existing and potential competitors have substantially greater financial, manufacturing, marketing and other resources than the Company. To compete successfully, the Company must continue to make substantial investments in its engineering and development, marketing, sales, customer service and support activities.

The Company considers its major competitors to be the CCTV and access control operations of Sensormatic Electronics Corporation, Burle (part of Philips Communication & Security Systems, Inc.), Panasonic, Pelco, Lenel, and Interlogics.

***Management Background***

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President and CEO, George Schultz  
Vice President of Sales and Marketing, Tammy Miller  
Vice President of Operations, Chris Streeter  
Chief Financial Officer, Theo Smith  
Controller, Fred Beck

Most of the management team has been with Oltrak since the current audit firm began auditing the company eight years ago. Over the years, the management team has been very easy to work with and shown a high level of competence. Furthermore, several sources of information indicate that the character of the management team is of a high quality. For example, the partner in charge of this audit has told you that the integrity of upper management is impeccable. He also commented to you that the CEO is one of the most honorable businessmen in the community and that he admires his leadership in the local community service organizations such as the United Way. Most people in the business community characterize Oltrak as being very supportive of community values and high ideals. This characterization stems largely from the high ideals of the management team.

***Additional Information***

- The company may have marginal ability to meet debt repayment requirements
- Significant declines in customer demand and increasing business failures have been prevalent in the industry and overall economy.

Now, consider the overall risk of material financial statement fraud, and answer the following question:

Based on all the information you have reviewed on Oltrak, Inc., what is the overall risk of material financial statement fraud for this company?

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

Based on the background information provided for Oltrak, Inc., please note if the following factors were considered in making your fraud risk assessment of Oltrak, Inc. If not considered, please select "0-did not consider". Otherwise, rate from 1 (extremely unimportant) to 7 (extremely important) how important each one is making a fraud risk assessment.

- a. High degree of competition or market saturation, accompanied by declining margins.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- b. The company may have marginal ability to meet debt repayment requirements

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- c. Due to the nature of the industry, the company has high vulnerability to rapid changes, such as changes in technology, product obsolescence, or interest rates.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- d. Significant declines in customer demand and increasing business failures have been prevalent in the industry and overall economy.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- e. Significant operations located or conducted across international borders where differing business environments and cultures exist.

☐ Did not consider

☐ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- f. There is a need to obtain additional debt or equity financing to stay competitive-including financing of major research and development or capital expenditures.

\_\_\_\_\_ Did not consider

\_\_\_\_\_ Did consider

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- g. Other factors considered, if any, list and rate from 1 (extremely unimportant) to 7 (extremely important):

The **audit partner's assessment** is that the risk of fraud is very high. This assessment is based on the following information:

The company has had the same auditors for 8 years. Since they have gained this very positive personal relationship with management they may not be as objective with their testing and be too trusting of what management tells them.

There community support could be used to overshadow there fraudulent ways.

The company appears to be under pressure to meet customer demands as several competitors have substantially greater financial, manufacturing, marketing and other resources than the Company. To compete successfully, the Company must continue to make substantial investments in its engineering and development, marketing, sales, customer service and support activities. That gives them incentive to cheat.

Sales have increased greatly over the last 20 years (last 5 of those 20 as well) even though there have been significant declines in customer demand and increasing business failures are occurring.

### The Expert System

Based on the background information provided for Oltrak Inc., please note if the following factors were present for Oltrak, Inc. If not present, please select "0-not present". Otherwise, please rate from 1 (extremely unimportant) to 7 (extremely important) how important each one is in making a fraud risk assessment.

- Domineering management behavior displayed in dealing with the auditor, especially involving attempts to influence the scope of the auditor's work.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Unusual rapid growth or profitability, especially compared with that of other companies in the same industry.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Excessive interest by management in maintaining or increasing the entity's stock price or earnings trend.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Frequent disputes with the current or predecessor auditor on accounting, auditing, or reporting matters.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Lack of monitoring of controls, including automated controls and controls over interim financial reporting (where external reporting is required).

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Difficulty in determining the organization or individual(s) that control(s) the entity.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Formal or informal restrictions on the auditor that inappropriately limit access to people or information or the ability to communicate effectively with the board of directors or audit committee.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- High degree of competition or market saturation, accompanied by declining margins.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Operating losses making the threat of bankruptcy, foreclosure, or hostile takeover imminent.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Recurring negative cash flows from operations or an inability to generate cash flows from operations while reporting earnings and earnings growth.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Marginal ability to meet debt repayment or other debt covenant requirements.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- High vulnerability to rapid changes, such as changes in technology, product obsolescence, or interest rates.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Significant declines in customer demand and increasing business failures in either the industry or overall economy.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Significant operations located or conducted across international borders where differing business environments and cultures exist.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- Need to obtain additional debt or equity financing to stay competitive-including financing of major research and development or capital expenditures.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

- High turnover of senior management, counsel, or board members.

\_\_\_ Not present

\_\_\_ Present

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

**EXPERT SYSTEM REPORT<sup>23</sup>**

<b>Deviation</b>	<b>Your response</b>	<b>System response</b>
Domineering management behavior displayed in dealing with the auditor, especially involving attempts to influence the scope of the auditor's work +1	<b>X</b>	<b>Y</b>
Unusual rapid growth or profitability, especially compared with that of other companies in the same industry None	<b>Z</b>	<b>Z</b>
.		
.		
.		

**Your initial fraud risk assessment was X**

Given this feedback, would you like to change your assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

\_\_\_\_\_ No  
 \_\_\_\_\_ Yes

	1	2	3	4	5	6	7
Extremely Low		Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High
Please explain/justify why you have (have not) changed your assessment for the overall risk of material financial statement fraud for Oltrak, Inc..							

Your final financial statement fraud risk assessment for Oltrak, Inc. was **Y (from right above)** and the recommended assessment is **Y**.

<sup>23</sup> Note this report includes all questions assessed in the experiment.

### Post-experiment Questionnaire

1. How many times within the last three years have you evaluated the risk of fraudulent activity on a client?

0      1      2      3      4      5      6      7      other:\_\_\_\_\_

2. How many times have you encountered fraudulent activity on a client?

0      1      2      3      4      5      6      7      other:\_\_\_\_\_

Please explain the situation (keeping the Company and Employees anonymous).

3. How many times have you used an expert system in the context of an audit?

0      1      2      3      4      5      6      7      other\_\_\_\_\_

If yes, please explain:

4. How important do you think the expert system was that you used in making an assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

1	2	3	4	5	6	7
Extremely Unimportant	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Extremely Important

5. Did you encounter any problems while working with this expert system? If yes, please explain.
6. What would you add to or delete from this expert system you used in making an assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

7. How prevalent do you think the following three elements of the fraud triangle were in Oltrak, Inc.?

a. Management has strong attitude/rationale to commit fraud

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

b. Management has opportunity to commit fraud

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

c. Management has incentives/pressures to commit fraud

1	2	3	4	5	6	7
Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

8. Do you feel that you were given enough information to make an assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

1	2	3	4	5	6	7
Extremely less than needed	Less than needed	Slightly Less than needed	Just enough	Slightly more than needed	More than needed	Extremely more than needed

9. How confident are you in your assessment for the overall risk of material financial statement fraud for Oltrak, Inc.?

1	2	3	4	5	6	7
Extremely unconfident	Very unconfident	Somewhat unconfident	Neutral	Somewhat confident	Very confident	Extremely confident

10. Did you find assessing the overall risk of material financial statement fraud for Oltrak, Inc. to be:

1	2	3	4	5	6	7
Extremely easy	Very easy	Somewhat easy	Moderate	Somewhat difficult	Very difficult	Extremely difficult

11. Please express any other comments you wish here.

Manipulation Checks (for all groups)

1) Did you learn the partners' assessment of fraud risk?

Check one of the following: \_\_\_\_Yes \_\_\_\_No

If you answered yes, what was the partners' assessment of the fraud risk?

	1	2	3	4	5	6	7
	Extremely Low	Very Low	Somewhat Low	Moderate	Somewhat High	Very High	Extremely High

Gender: Male    Female

Highest degree obtained: A.S./A.A.                      B.S./B.A.                      M.S./M.A.  
    MPA/MSA                      MBA                      Ph.D.                      Other \_\_\_\_\_

Professional Designation:    CPA                      CIA                      CMA                      CFA  
    CFE    EA                      CGFM                      Other \_\_\_\_\_

Years of professional working experience: \_\_\_\_\_    Present  
 position: \_\_\_\_\_

Are you with the same public accounting firm you started your career with? Yes    No

If not, which type of firm did you start with?    Big 4                      National                      Regional  
    Other \_\_\_\_\_

How many years were you employed with this first firm? \_\_\_\_\_

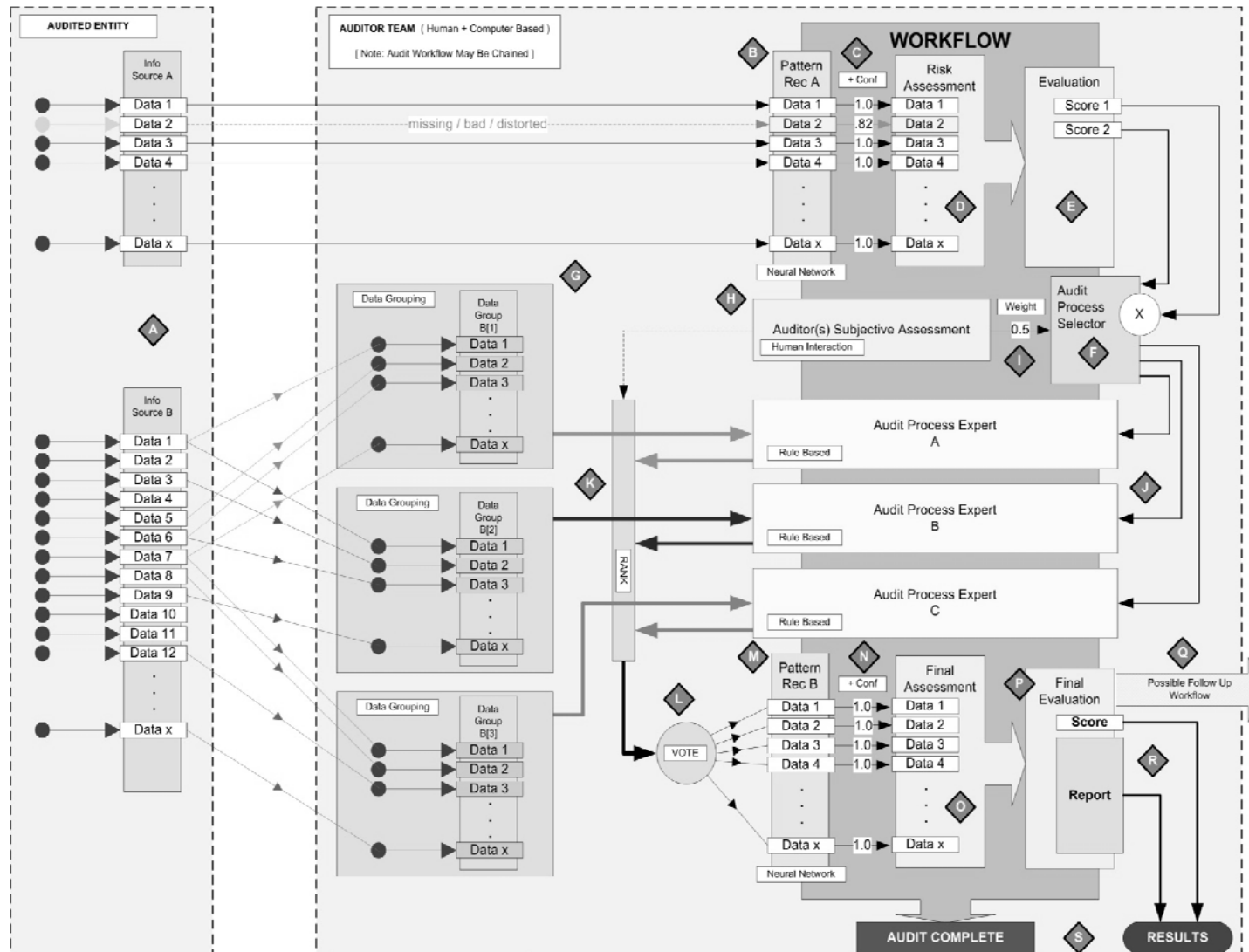
Have you worked at any other firms in between your starting and present firm?    Yes  
    No

If yes, which types of firms and for how long did you work at each firm? Please list in  
 chronological order.

\_\_\_\_\_

PLEASE DO NOT DISCUSS THIS EXPERIMENT WITH ANYONE WHO WILL OR  
 MIGHT BE PARTICIPATING. THANK YOU VERY MUCH FOR YOUR TIME AND  
 PARTICIPATION.

## Appendix C: AudEx (Audit Data Assessment System)



The idea for the specific expert system used in the current studies was adopted from a pharmacy consulting company<sup>24</sup>, currently used in the healthcare industry to provide assessments. AudEx, the actual system used in the current studies, was created and developed for the purposes of these studies based on the provided specifications. The above pictorial shows the flow of how the expert system operates. Section A represents the source of financial, corporate, and/or behavioral data related to the audited entity. The *Info Source A* is a normalized data set that can be used to determine the best audit method used. Section A displays two possible ways to input and handle the original data. The first is to input all data obtained (combining *Info Source A* and *Info Source B* data) and having the system determine which data is needed and dropping the unnecessary information. The second is to input key information and the system then performs sections B through G and decides what additional data is needed to perform the required procedures based on the initial assessment of the data provided.

Section B contains the neural network that is trained on pattern recognition and basically projects the approach that should be taken. If information provided by section A is deemed unreliable, missing, distorted, or corrupted, the *Pattern Rec A* can propose a missing value (with a confidence factor, as show in section C) based on a model of prior learned examples of similarly configured audited entities. This will serve to reduce, if not fully eliminate, the dilution effect given the system received enough training scenarios to incorporate into its mode.

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<sup>24</sup>Neuron Dynamics, LLC is a privately held corporation organized to produce income and long-term capital appreciation by developing and marketing advanced healthcare technology solutions. The solutions center on adaptive intelligent technology that is capable of learning from humans, their experience and knowledge, so their value can be duplicated. The company website is as follows: <http://neurondynamics.com/>

All of the information that passes through the system has an associated confidence factor, displayed in section C. If the data comes through fully readable, then it will be give a 1.0 confidence, otherwise it will be of a lesser value; such as Data 2, from *Info Source A*.

Sections D and E are performed as a pair because when an auditor develops a judgment (*score*), it is determined by examining the risk assessment and evaluation together. Specifically, section D is the scaled/normalized data which passes into a defined risk assessment template. Section E utilizes either a neural network or a rules-based model to generate a number of scores.

By using fuzzy logic, the scores output from section E select the most appropriate set of rules-based audit process experts to run against the supplied data from section G. Section G provides the appropriate set of data to the rules-based audit process experts. This occurrence in section F is determining what additional steps need to be performed based on these scores and the rules-based is trained by the auditor from doing different types of audits. The system will have training so it can be specific to different client industries. Section I is the weighting factor for human input, decided by the human. The scale is from 0.0 – human input ignored to 1.0 – human input takes precedent, i.e. training mode. When the auditor is training the system, this will be set at 1.0, and then it will gradually decrease so humans have partial, and eventually no, influence on which expert to use. As the system gets smarter from training and use the human's suggestion will be identical to the computer's suggestion.

The rules-based audit experts are displayed in section J. These employ expert rules created by human expert auditors and are designed to perform a high level audit in

an effort to create a consistent high level base line; ultimately reducing the effects of dilution and tendencies towards overly conservative audits. The results from the selected audit process experts are rules-base audit process experts and the human auditors are combined into a data set. Any post processing or scaling of the results may be done in this section prior to the voting stage, occurring in section L.

Section L utilizes a voting algorithm to provide a ranked set of assessments related to the results of the prior sections. The goal is to put the results into a standardized result format, consensus, defined by the human auditors. The voting rule on how to combine and which should be used is pre-programmed by the audit expert.

Another pattern recognition is performed at section M on the resultant data in order to identify and classify what type of problems or fraud may be taking place. The system will look for prior voting patterns and it can determine if it is fraud, a misstatement, or error. This combined with section N will produce the final assessment, section O. Section N contains the resultant classifications confidence values for each attribute and section O performs the final assessment of the result set.

Section P generates the final score by use of a neural network, rule, statistic, or genetic algorithm. If defined, the result may be passed onto another workflow for further assessment, processing, or action in section Q. These auditor team units may be chain-linked together to perform much more in depth analysis and reporting to create a complex process by combining each individual process. The final report is generated in section R, and the workflow ends and presents findings and reports in section S.

## Appendix D: Operators and Their Definitions Used in Coding of Verbal Protocols

Operator	Notation	Brief Definition
<i>Task Structuring</i>		
1. Reading	RD	Assigned when the subject reads something from the case or the question.
2. Plan	P	Assigned when the subject states what he/she is going to do.
<i>Information Acquisition</i>		
3. Fact from case	FC	Assigned when the subject states a fact from the case information.
4. Fact from external information sources	FE	Assigned when the subject states a fact from an external source.
<i>Analytical</i>		
5. Inference	I	Assigned when the subject infers or assumes something from the case information provided.
6. Query	Q	Assigned when the subject raises a question about the case information or factor assessing.
<i>Action</i>		
7. Elimination	EL	Assigned when the subject eliminates a factor or possible assessment.
8. Assessment	AT	Assigned when the subject makes an assessment on a risk factor.
9. No Revision	NR	Assigned when the subject did not revise a previous assessment.
10. Revision	RV	Assigned when the subject revises a previous assessment.

11. Downgraded	DG	Assigned when the subject revises and downgrades a previous assessment.
12. Upgraded	UG	Assigned when the subject revises and upgrades a previous assessment.
13. Reason	R	Assigned when the subject states a reason why he/she is doing something or rating a factor.
14. Specific Reasons/Factors Stated		Assigned when the subject states a specific financial or non-financial factor from the case information.
<i>Financial Related Factors</i>		
Debt	DP	Assigned when the subject refers to debt (i.e. debt payments, debt financing) as a considered factor.
Fixed Assets	FAS	Assigned when the subject refers to fixed assets (i.e. manual vs. computer) as a considered factor.
Profitability	PF	Assigned when the subject refers to the profitability of the company as a considered factor.
Stock price or earnings	SE	Assigned when the subject refers to the stock price or earnings of the company as a considered factor.
Sales or Revenue	SL	Assigned when the subject refers to sales and/or revenues and the analytical trends of them as a considered factor.
Net Income	NI	Assigned when the subject refers to the overall net income (bottom line) and the analytical trends of it as a considered factor.
Assets	AST	Assigned when the subject refers to the assets of the company as a considered factor.

Inventory	INV	Assigned when the subject refers to inventory and its related issues of the company as a considered factor.
Management Compensation	MP	Assigned when the subject refers to compensation of management and items possibly included in it as a considered factor.
Costs or Expenses	CTS	Assigned when the subject refers to the costs and expenses of the company as a considered factor.
Cash	CH	Assigned when the subject refers to the cash and analytical trends of it as a considered factor.
Historical Data	HD	Assigned when the subject refers to the historical financial data of the company as a considered factor.
<i>Non-Financial Related Factors</i>		
Market	MK	Assigned when the subject refers to the conditions of the market as a considered factor.
Customers	CU	Assigned when the subject refers to customers and the demand trends of them, both to the company and industry, as a considered factor.
Business Failures	BF	Assigned when the subject refers to the company's business failures as a considered factor.
Global Operations	GO	Assigned when the subject refers to the global operations, issues, and affairs of the company as a considered factor.
Organization structure	OS	Assigned when the subject refers to the organization's structure and upper level management as a considered factor.

Competition	CP	Assigned when the subject refers to the company's competition and issues related to it as a considered factor.
Turnover	TO	Assigned when the subject refers to turnover within the company as a considered factor.
Management Integrity	MI	Assigned when the subject refers to the integrity of management as a considered factor.
Previous Experience	PE	Assigned when the subject refers to the auditor's previous experience with the company as a considered factor.
Controls	CT	Assigned when the subject refers to the internal controls in place at the company as a considered factor.
Economy	EC	Assigned when the subject refers to the overall economy and the conditions of it as a considered factor.
Public Company	PT	Assigned when the subject refers to the company as being public and risk associated with that as a considered factor.
Industry	ID	Assigned when the subject refers to the conditions and effects of the company's industry as a considered factor.
Professional Skepticism	PS	Assigned when the subject refers to professional skepticism of either the auditor or management as a considered factor.
Fraud Interviews	FI	Assigned when the subject refers to conducting fraud interviews with the employees of the company as a considered factor.

Auditor Consistency	ADC	Assigned when the subject refers to the longevity of employment of the current auditor as a considered factor.
Going Concern	GC	Assigned when the subject refers to the company possibly facing a going concern as a considered factor.
Patent	PAT	Assigned when the subject refers to the patent expiring as a considered factor.
Employee Strike	STK	Assigned when the subject refers to the possible employee strike occurring as a considered factor.

### Appendix E: Summary of Overall Results - Relevant Only Information Participants

		Participants											
		<b>1</b>		<b>2</b>		<b>3</b>		<b>4</b>		<b>5</b>		<b>6</b>	
<i>Time Taken</i>		76 mins		47 mins		74 mins		46 mins		92 mins		41 mins	
<i>Experience</i>		5 years		6 years		3 years		5 years		5 years		4 years	
<i>Confidence</i>		5		5		5		6		6		6	
<b>Operator</b>	<b>Notation</b>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>
<i>Task Structuring</i>													
1. Reading	RD	13	3.03	10	5.78	3	4.84	5	5.75	4	9.09	7	12.07
2. Plan	P	18	4.2	6	3.47	4	6.45	3	3.45	0	-	1	1.72
			7.23		9.25		11.3		9.2		9.09		13.8
<i>Information Acquisition</i>													
3. Fact from case	FC	24	5.59	8	4.62	1	1.61	4	4.6	2	4.55	3	5.17
4. Fact from external sources	FE	20	4.66	5	2.89	1	1.61	0	-	0	-	0	-
			10.3		7.51		3.23		4.6		4.55		5.17
<i>Analytical</i>													
5. Inference	I	53	12.35	23	13.29	2	3.23	16	18.39	0	-	0	-
6. Query	Q	0	-	2	1.16	2	3.23	0	-	0	-	4	6.9
			12.4		14.5		6.45		18.4		-		6.9

*Action*

7. Elimination	EL	14	3.26	1	0.58	0	-	0	-	0	-	0	-
8. Assessment	AT	38	8.86	25	14.45	21	33.87	14	16.09	23	52.27	24	41.38
9. No Revision	NR	3	0.7	0	-	1	1.61	0	-	1	2.27	2	3.45
10. Revision	RV	2	0.47	0	-	0	-	1	1.15	0	-	0	-
11. Downgraded	DG	8	1.86	2	1.16	0	-	0	-	1	2.27	0	-
12. Upgraded	UG	11	2.56	2	1.16	0	-	1	1.15	1	2.27	1	1.72
13. Reason	R	57	13.29	38	21.97	10	16.13	15	17.24	4	9.09	6	10.34
			31		39.3		51.6		35.6		68.18		56.9

*Specific Reasons/Factors Stated  
Financial Related Factors*

Debt	DP	11	2.56	2	1.16	2	3.23	4	4.6	0	-	2	3.45
Fixed Assets	FAS	0	-	0	-	0	-	0	-	0	-	0	-
Profitability	PF	6	1.4	4	2.31	0	-	2	2.3	0	-	0	-
Stock price or earnings	SE	5	1.17	2	1.16	1	1.61	0	-	0	-	0	-
Sales or Revenue	SL	12	2.8	1	0.58	0	-	7	8.05	0	-	1	1.72
Net Income	NI	3	0.7	0	-	0	-	1	1.15	0	-	1	1.72
Assets	AST	3	0.7	0		0		1	1.15	0		0	

				-		-		-		-			
Inventory	INV	0	-	0	-	2	3.23	0	-	0	-	1	1.72
Management Compensation	MP	3	0.7	3	1.73	2	3.23	0	-	0	-	0	-
Costs or Expenses	CTS	4	0.93	0	-	0	-	0	-	0	-	0	-
Cash	CH	3	0.7	0	-	0	-	0	-	0	-	0	-
Historical Data	HD	3	0.7	1	0.58	0	-	0	-	0	-	0	-
			12.4		7.51		11.3		17.2		-		8.62

*Non-Financial Related Factors*

Market	MK	3	0.7	0	-	0	-	0	-	0	-	0	-
Customers	CU	7	1.63	2	1.16	0	-	3	3.45	1	2.27	2	3.45
Business Failures	BF	3	0.7	0	-	0	-	1	1.15	1	2.27	0	-
Global Operations	GO	10	2.33	2	1.16	1	1.61	0	-	0	-	0	-
Organization structure	OS	16	3.73	4	2.31	1	1.61	1	1.15	0	-	1	1.72
Competition	CP	9	2.1	12	6.94	0	-	0	-	2	4.55	2	3.45
Turnover	TO	3	0.7	0	-	1	1.61	0	-	0	-	0	-
Management Integrity	MI	13	3.03	3	1.73	2	3.23	3	3.45	1	2.27	0	-
Previous Experience	PE	4	0.93	1	0.58	0	-	1	1.15	0	-	0	-

Controls	CT	9	2.1	8	4.62	1	1.61	3	3.45	0	-	0	-
Economy	EC	11	2.56	0	-	0	-	0	-	0	-	0	-
Public Company	PT	1	0.23	1	0.58	1	1.61	0	-	0	-	0	-
Industry	ID	12	2.8	3	1.73	1	1.61	0	-	1	2.27	0	-
Professional Skepticism	PS	3	0.7	0	-	1	1.61	0	-	0	-	0	-
Fraud Interviews	FI	4	0.93	0	-	0	-	0	-	0	-	0	-
Auditor Consistency	ADC	7	1.63	2	1.16	0	-	1	1.15	2	4.55	0	-
Going Concern	GC	0	-	0	-	1	1.61	0	-	0	-	0	-
Patent	PAT	0	-	0	-	0	-	0	-	0	-	0	-
Employee Strike	STK	0	-	0	-	0	-	0	-	0	-	0	-
			26.8		22		16.1		14.9		18.18		8.62
		<b>429</b>	<b>100</b>	<b>173</b>	<b>100</b>	<b>62</b>	<b>100</b>	<b>87</b>	<b>100</b>	<b>44</b>	<b>100</b>	<b>58</b>	<b>100</b>

## Appendix F: Summary of Overall Results - Relevant and Irrelevant Information Participants

		Participants											
		<b>7</b>		<b>8</b>		<b>9</b>		<b>10</b>		<b>11</b>		<b>12</b>	
		<i>Time Taken</i>	53 mins	<i>Experience</i>	5 years	<i>Confidence</i>	6	<i>Time Taken</i>	49 mins	<i>Experience</i>	3 years	<i>Confidence</i>	6
		<i>Time Taken</i>	53 mins	<i>Experience</i>	5 years	<i>Confidence</i>	6	<i>Time Taken</i>	44 mins	<i>Experience</i>	4 years	<i>Confidence</i>	2
		<i>Time Taken</i>	41 mins	<i>Experience</i>	3 years	<i>Confidence</i>	4	<i>Time Taken</i>	33 mins	<i>Experience</i>	3 years	<i>Confidence</i>	2
		<i>Time Taken</i>	47 mins	<i>Experience</i>	5 years	<i>Confidence</i>	6						
<b>Operator</b>	<b>Notation</b>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>
<i>Task Structuring</i>													
1. Reading	RD	9	6.47	7	9.59	3	5.77	10	7.75	4	7.02	5	5.38
2. Plan	P	0	-	0	-	0	-	3	2.33	0	-	0	-
			6.47		9.59		5.77		10.08		7.02		5.38
<i>Information Acquisition</i>													
3. Fact from case	FC	5	3.6	2	2.74	0	-	14	10.85	2	3.51	4	4.3
4. Fact from external sources	FE	1	0.72	0	-	0	-	0	-	0	-	0	-
			4.32		2.74		-		10.85		3.51		4.3
<i>Analytical</i>													
5. Inference	I	3	2.16	0	-	4	7.69	2	1.55	2	3.51	3	3.23
6. Query	Q	6	4.32	6	8.22	3	5.77	2	1.55	3	5.26	4	4.3
			6.47		8.22		13.46		3.11		8.77		7.53

*Action*

7. Elimination	EL	2	1.44	0	-	0	-	0	-	0	-	0	-
8. Assessment	AT	37	26.62	30	41.1	18	34.62	33	25.58	28	49.12	31	33.33
9. No Revision	NR	1	0.72	1	1.37	1	1.92	3	2.33	0	-	0	-
10. Revision	RV	0	-	0	-	0	-	0	-	0	-	0	-
11. Downgraded	DG	4	2.88	0	-	1	1.92	2	1.55	0	-	3	3.23
12. Upgraded	UG	2	1.44	6	8.22	00	-	3	2.33	3	5.26	5	5.38
13. Reason	R	44	31.65	10	13.7	7	13.46	20	15.5	5	8.77	12	12.9
			64.75		64.38		51.92		47.29		63.16		54.84

*Specific Reasons/Factors Stated**Financial Related Factors*

Debt	DP	1	0.72	0	-	3	5.77	3	2.33	0	-	0	-
Fixed Assets	FAS	3	2.16	0	-	0	-	4	3.1	1	1.75	4	4.3
Profitability	PF	0	-	0	-	0	-	0	-	0	-	0	-
Stock price or earnings	SE	0	-	0	-	0	-	0	-	0	-	0	-
Sales or Revenue	SL	0	-	0	-	2	3.85	6	4.65	0	-	1	1.08
Net Income	NI	1	0.72	0	-	1	1.92	2	1.55	0	-	1	1.08
Assets	AST	0	-	0	-	0	-	1	0.78	0	-	0	-
Inventory	INV	0	-	0	-	0	-	0	-	0	-	0	-

Management Compensation	MP	2	1.44	0	-	0	-	0	-	0	-	0	-
Costs or Expenses	CTS	0	-	0	-	0	-	0	-	0	-	0	-
Cash	CH	0	-	0	-	0	-	1	0.78	0	-	0	-
Historical Data	HD	0	-	0	-	0	-	0	-	0	-	0	-
			5.04		-		11.54		13.18		1.75		6.45

*Non-Financial Related Factors*

Market	MK	0	-	0	-	0	-	0	-	0	-	0	-
Customers	CU	2	1.44	0	-	1	1.92	0	-	0	-	2	2.15
Business Failures	BF	0	-	0	-	0	-	0	-	0	-	0	-
Global Operations	GO	4	2.88	0	-	0	-	0	-	0	-	1	1.08
Organization structure	OS	1	0.72	0	-	1	1.92	1	0.78	0	-	1	1.08
Competition	CP	4	2.88	2	2.74	2	3.85	1	0.78	0	-	3	3.23
Turnover	TO	1	0.72	0	-	0	-	0	-	0	-	1	1.08
Management Integrity	MI	2	1.44	4	5.48	0	-	4	3.1	6	10.53	5	5.38
Previous Experience	PE	0	-	1	1.37	0	-	1	0.78	1	1.75	0	-
Controls	CT	1	0.72	1	1.37	4	7.69	0	-	1	1.75	2	2.15

Economy	EC	1	0.72	0	-	0	-	1	0.78	0	-	1	1.08
Public Company	PT	0	-	2	2.74	1	1.92	0	-	0	-	0	-
Industry	ID	2	1.44	0	-	0	-	4	3.1	0	-	1	1.08
Professional Skepticism	PS	0	-	0	-	0	-	0	-	0	-	0	-
Fraud Interviews	FI	0	-	0	-	0	-	2	1.55	0	-	0	-
Auditor Consistency	ADC	0	-	0	-	0	-	1	0.78	0	-	0	-
Going Concern	GC	0	-	0	-	0	-	1	0.78	0	-	0	-
Patent	PAT	0	-	1	1.37	0	-	2	1.55	1	1.75	1	1.08
Employee Strike	STK	0	-	0	-	0	-	2	1.55	0	-	2	2.15
			<i>12.95</i>		<i>15.07</i>		<i>17.31</i>		<i>15.5</i>		<i>15.79</i>		<i>21.51</i>
		<b>139</b>	<b>100</b>	<b>73</b>	<b>100</b>	<b>52</b>	<b>100</b>	<b>129</b>	<b>100</b>	<b>57</b>	<b>100</b>	<b>93</b>	<b>100</b>

## VITA

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- 1981            Born November 5 in Livingston, New Jersey.
- 1999            Graduated from Bloomfield High School, Bloomfield, New Jersey.
- 1999 - 2003    Attended The College of New Jersey, Ewing, New Jersey.
- 2000            Employed by Paul Goldman, CPA, Nutley, New Jersey, Staff Accountant.
- 2002            Employed by PricewaterhouseCoopers, LLP, Florham Park, New Jersey, Assurance and Business Advisory Services Intern.
- 2003            Bachelors of Science in Accounting, Minor in Criminology and Justice Studies, The College of New Jersey
- 2003 - 2005    Employed by PricewaterhouseCoopers, LLP, Florham Park, New Jersey, Associate for Assurance and Business Advisory Services.
- 2005 - 2008    Employed by J. H. Cohn, LLP, Roseland, New Jersey, Audit Manager.
- 2008 - 2012    Attended Rutgers University, Newark, New Jersey.
- 2008 - 2012    Employed by Rutgers University, Newark, New Jersey, Research Assistant.
- 2009            Article: Nouri, H. and Lombardi, D. (2009), "Auditors' Independence: An Analysis of Montgomery's Auditing Textbooks in the 20th Century", *The Accounting Historians Journal*, vol. 36, no. 1, pp. 81-112.
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