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Computer Forensics for Accountants

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COMPUTER FORENSIC PROJECTS FOR ACCOUNTANTS

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ABSTRACT

Digital attacks on organizations are becoming more common and more sophisticated. Firms are interested in providing data security and having an effective means to respond to attacks. Accountants possess important investigative and analytical skills that serve to uncover fraud in forensic investigations. Some accounting students take courses in forensic accounting but few colleges offer a course in computer forensics for accountants. Educators wishing to develop such a course may find developing the curriculum daunting. A major element of such a course is the use of forensic software. This paper argues the importance of computer forensics to accounting students and offers a set of exercises to provide an introduction to obtaining and analyzing data with forensics software that are available free online. In most cases, figures of important steps are provided. Educators will benefit when developing the course learning goals and curriculum.

Keywords: Computer forensics; forensic accounting; accounting education

1. INTRODUCTION

Increased reliance on both technological and accounting skills has been recognized in research (Albrecht and Sack, 2000; Tan et al., 2004). The increase of digital fraud has led many accountants to acquire advance information technology (IT) skills and certifications in order to qualify as IT auditors and forensic accountants (Davis et al., 2007). As routine accounting tasks are becoming highly automated an accountant's value is more likely to be determined by higher order skills such as those needed in forensic analysis (Hunton, 2002).

A data breach can result in extensive losses in both profits and reputation. The Target data breach that affected as many as 110 million customers received substantial adverse publicity and the total dollar loss is expected to be high (LA Times).

Companies may be legally obligated to provide confidentiality. Failure to protect personally identifiable information (PPI) may subject the organization to fines and other penalties. The Gramm-Leach-Bliley Act and Health Insurance Portability Act stipulate that financial and health organizations are accountable for the safe guarding of PPI (Pearson, 2008) and firms that operate abroad may be subject to the European Union Data Protection Directive which places stringent rules on the protection of private information.

Professional and regulatory bodies recognize the value of IT to accountants. The American Institute of Certified Public Accountants recognizes the importance of technology to the organization and to accountants. In its 2013 List of Top 10 Technology Initiatives the AICPA listed "Securing the IT Environment", "Ensuring Privacy" and "Preventing and Responding to Computer Fraud" as top priorities (AICPA, 2013). The Public Company Accounting Oversight Board (PCAOB) has recommended that auditors receive IT training (O 'Donnell and Moore, 2005). An analysis of 595 job listings for IT auditors found that a large percentage specifically mentioned technical skills/abilities including networking, security, database, experience with IT controls, and computer-assisted audit tools and techniques (Merhout and Buchman, 2007). The Sarbanes-Oxley Act of 2002 and SAS No. 99 (SAS 99), "Consideration of Fraud in a Financial Statement Audit," extended expectations for auditors stating that,

> "Electronic evidence often requires extraction of the desired data by an auditor with IT knowledge and skills or the use of an IT specialist … it may be necessary for the auditor to employ computer-assisted audit techniques … to identify the journal entries and other adjustments to be tested."

The increased sophistication and complexities of information systems have created vulnerabilities that can be exploited to damage organizations by compromising confidential personal information, allowing unauthorized access to sensitive projects and intellectual property, and by concealing financial statement frauds and misappropriation of assets. In order to assess the nature and extent of these threats, to acquire and analyze evidence and to maintain a proper chain of custody, forensic accountants must possess a basic understanding of computer forensic techniques. This paper presents a set of exercises and projects that will be useful to educators creating an introductory course in computer forensics for accountants. This provides and important element in curriculum development and allows students to learn these skills in a hands-on environment. The exercises and projects use widely recognized software that is freely available.

2. COMPUTER FORENSICS FOR ACCOUNTANTS

Nelson et al. (2010) define computer forensics as "The process of applying scientific methods to collect and analyze data and information that can be used as evidence." Thus, computer forensics addresses the methods and procedures necessary to investigate possible criminal and non-criminal conduct involving digital data. From an organizational perspective, investigations should initially proceed with the assumption that the case may be of a criminal nature so that all steps meet the statutory rules for admission of evidence. An understanding of computer forensics allows the accountant to make knowledgeable decisions regarding what steps to take and how to proceed during an investigation and not taint the evidence.

Computer forensics is considered by some to be dominated by IT and law-enforcement. Although both play important roles, there are reasons that forensic analysis requires the attention of accountants. Accountants, in particularly auditors, are highly familiar with corporate information systems (IS), policies and internal controls, and possess advanced analytical skills. Neither IT nor law-enforcement have a broad understanding of the overall systems and databases, access rights, organizational roles and responsibilities which are critical to an effective forensic investigation. Furthermore, they may have priorities that may not parallel and could even conflict with organizational needs. For these reasons, the combination of accounting and computer forensics provides an unmatched capability to investigate, analyze and report on suspicious patterns and anomalies and to follow the trail of unauthorized activities (Kearns, 2010).

Most firms have one or more internal auditors with forensic skills who are responsible for fraud detection and investigation (Pearson et al., 2008). Evidence in most organizational fraud cases is in digital form. With the need for increased vigilance it is imperative that these professionals be able to obtain, manage, and analyze digital forensic data in an effective manner. These accountants need, at minimum, training in the basics of computer forensics.

3. COMPUTER FORENSIC TRAINING

IT is now considered a basic skill for accountants (Hurt, 2007) and most undergraduate accounting students acquire an intermediate level IT competency. AACSB accredited schools usually include three courses in computer related knowledge and skills. First is an introductory computer class that covers productivity software including word processing, spreadsheets, database, email and slide presentation software. Second is a management information systems (MIS) class that covers the foundations of information resources, system management and security techniques, database concepts and IS management principles. Third is a course in accounting information systems (AIS) that focuses on internal controls for IS, transaction systems, systems design and documentation, system security, computer fraud, and IT governance. The AIS class may also cover advanced spreadsheet and database knowledge and generalized audit software such as Audit Control Language (Coglitore and Matson, 2007).

Some accounting programs now offer courses in forensic accounting and a few colleges have full programs in forensic accounting. Graduate programs may offer an emphasis or track in forensic accounting in the MBA or Masters of Accountancy programs. The composition of the courses varies depending upon the number of courses offered. Schools that offer a full program or major will have a broader offering than those that only offer an emphasis or track in forensic accounting. Acquiring these skills can increase market appeal particularly for accounting students who wish to work as internal auditors or as IT or fraud auditors or as agents for the IRS or FBI. As a result of the increasing need for digital security and the importance of uncovering corporate fraud many universities are also creating courses in computer forensics (Busing et al., 2006).

Forensic accounting represents an integration of accounting, auditing and investigative skills that support the acquisition, maintenance, and analysis of relevant information in a manner that would be acceptable for judicial review and meet the requirements of professional oversight. It also extends to the formulation and presentation of findings in formal reports and court testimony as an expert witness. Forensic accountants command a set of skills that transcends the traditional expectations of accountants. These skills are acquired and enhanced through audit experience and increased investigative training. This allows the forensic accountant to analyze and interpret more complex business and non-business issues in a manner that meets the highest requirements of reliability and integrity. As such, forensic accountants may be employed in a public or private capacity and play important roles in internal auditing departments of banks and insurance companies, governmental and law enforcement agencies, and as self-employed contractors for individuals and attorneys. Thus, the market for forensic accountants and the required skill sets are very well defined.

4. COMPUTER FORENSICS COURSE EXERCISES AND PROJECTS

Forensic accountants are often deficient in the understanding of computer forensics for several reasons. Many schools do not offer such a course because they lack qualified instructors. Also, the topics are not covered on the CPA exam and a large percentage of accounting students plan to acquire a CPA or similar certification such as CMA or CIA, none of which require the technical skills of computer forensics. Finally, accounting students who plan to take the CPA exam may have to meet the 150 hour rule adopted by many states and may see forensic skills as ones they can acquire in the future (Seda et al., 2008).

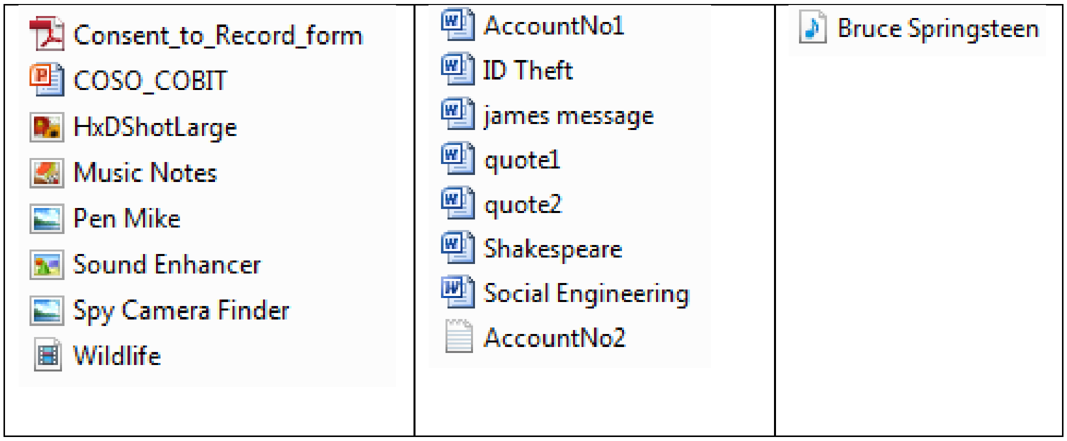
This deficiency, however, directly impacts the ability and effectiveness of the forensic accountant and makes him or her more reliant upon IT for all steps requiring computer forensic analysis. Also, students may recognize that the computer forensic skills are special and may lead to careers in forensic accounting and IT auditing. Educators who recognize the importance of computer forensic skills will be interested in exercises and projects that provide the accounting student with basic computer forensic techniques. The exercises and projects that follow introduce several widely recognized software products that are important to forensic analysis. Among other things, these projects illustrate how fraudsters can hide important information in files, how to inspect files for hidden data, how to acquire images from a suspect drive, how to recover deleted files and how to calculate hash values to insure the integrity of files. A set of student files for the exercises and projects are available upon request from the author.

4.1 Exercise and Project Requirements

The projects use several applications available in demo versions.

1. WinHex Hexadecimal Editor: http://download.cnet.com/WinHex/3000-2352_4-10057691.html
2. AccessData FTK Analyzer: http://www.accessdata.com/support/product-downloads/ftk-download-page
3. HashCalc: http://download.cnet.com/HashCalc/3000-2250_4-10130770.html
4. Eraser: http://download.cnet.com/Eraser/3000-2092_4-10231814.html

The following files are used in the exercises and projects and can be downloaded in zipped format. They should be placed in a work-folder named Projects.



Consent_to_Record_form
COSO_COBIT
HxDShotLarge
Music Notes
Pen Mike
Sound Enhancer
Spy Camera Finder
Wildlife

AccountNo1
ID Theft
james message
quote1
quote2
Shakespeare
Social Engineering
AccountNo2

Bruce Springsteen

4.2 Computer Forensic Exercises

These exercises are intended to introduce the accounting student to knowledge and skills basic to computer forensics. All of the exercises are short and can be performed in-class or as take-home assignments.

Exercise 1: Numbering Systems

Tantamount to the use of forensic software is the knowledge of the binary and hexadecimal numbering systems. All modern numbering systems have two things in common: (1) digits, and (2) placeholders. Each placeholder represents the base raised to a higher power. In the following tables, the second row is the placeholder and the third row is the power to which each value is raised. In the first

Placeholder and Power (Note that the power is always one less than the placeholder.)									
10	9	8	7	6	5	4	3	2	1
9	8	7	6	5	4	3	2	1	0

DECIMAL (Base 10 - Ten digits 0-9)

Placeholder and Power									
10	9	8	7	6	5	4	3	2	1
10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0

Thus, in base 10, the value 8,673 equals:

$8 \times 10^3 + 6 \times 10^2 + 7 \times 10^1 + 3 \times 10^0 = 8{,}000 + 600 + 70 + 3$

BINARY (Base 2 – Two digits 0 and 1)

Placeholder and Power									
10	9	8	7	6	5	4	3	2	1
2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Thus, in base 2, the value 1100 1100 equals:

$1 \times 2^7 + 1 \times 2^6 + 1 \times 2^3 + 1 \times 2^2 = 128 + 64 + 8 + 4 = 204_{\text{base10}}$

HEXADECIMAL (Base 16 - Sixteen digits 0-F where A=10, B=11, C=12, D=13, E=14, F=15)

Placeholder and Power									
10	9	8	7	6	5	4	3	2	1
16^9	16^8	16^7	16^6	16^5	16^4	16^3	16^2	16^1	16^0

Thus, in base 16, the value 1A5F equals:

$1 \times 16^3 + 10 \times 16^2 + 5 \times 16^1 + 15 \times 16^0 = 4096 + 2560 + 80 + 15 = 6{,}751_{\text{base10}}$

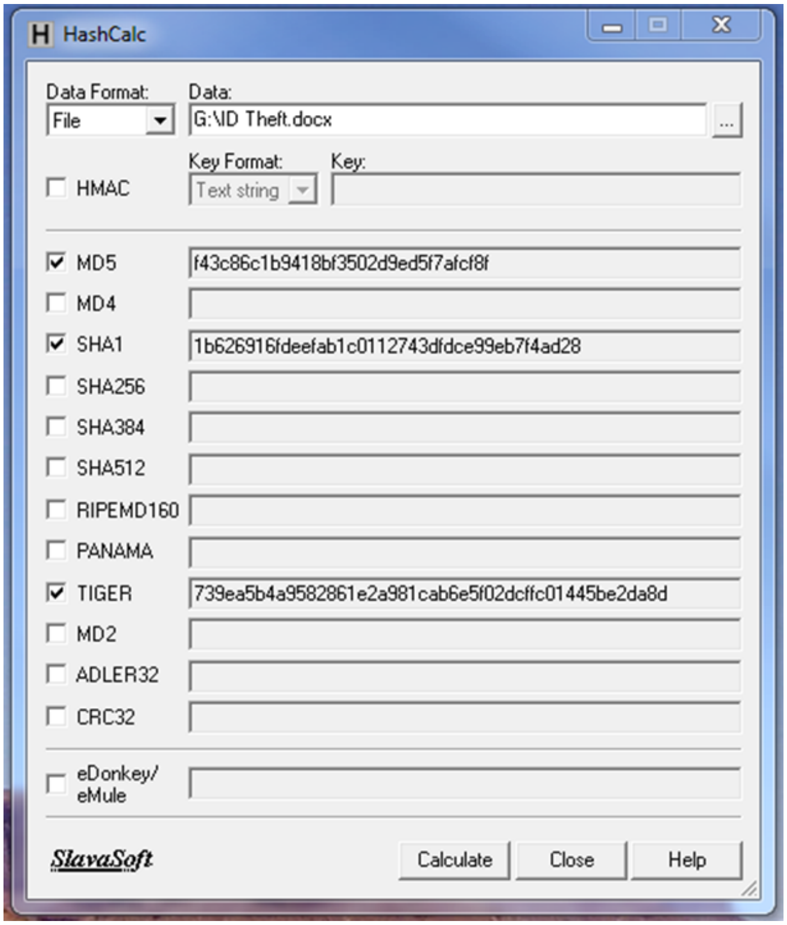
Student Exercises:	**Answers (in decimal values)**
Convert each of the following to decimal values.	
1. Binary: 1111	1. 15
2. Binary: 1111 1111	2. 255
3. Binary: 1 0000 0000	3. 256
4. Binary: 1010 1010	4. 170
5. Hex: 123	5. 368
6. Hex: ABC	6. 2748
7. Hex: FF	7. 255
8. Hex: 100	8. 256

Exercise 2: Creating Hash Values (Checksums)

A hash, also known as a checksum, is a value that has no real meaning. Hashes are often used as control values such as the sum of employee id numbers for payroll applications. In accounting and forensics, hash values are created by computer algorithms that create a unique key string for any size of file. In most of our projects we would hash the file before and after testing to insure that the file itself has not been modified in any way.

The file size has no impact on the string length which is determined by the algorithm. In forensics the algorithms, MD5 and SHA1 have been popular. Calculators are readily available. We use HashCalc.

1. Open HashCalc© and note the number of hash types. Open the MS Word file ID Theft.
2. Select the MD5, SHA1 and Tiger hash algorithms. Click Enter.
3. Take a screenshot of the results and add to your Results file and save to your Project_Work folder. See Figure 1.
4. Close the ID Theft file.
5. Open the ID Theft file and again select the MD5, SHA1 and Tiger hash algorithms. Click Enter.
6. Compare the results to those from your previous screenshot. They should be the same.
7. At the bottom of the file type OK. Save the file.
8. Open the ID Theft file and again select the MD5, SHA1 and Tiger hash algorithms. Click Enter.
9. Compare the results to those from your previous screenshot. They should be the different.



Data Format: File
Data: G:\ID Theft.docx

□ HMAC Key Format: Text string Key:

☑ MD5 f43c86c1b9418bf3502d9ed5f7afcf8f
□ MD4
☑ SHA1 1b626916fdeefab1c0112743dfdce99eb7f4ad28
□ SHA256
□ SHA384
□ SHA512
□ RIPEMD160
□ PANAMA
☑ TIGER 739ea5b4a9582861e2a981cab6e5f02dcffc01445be2da8d
□ MD2
□ ADLER32
□ CRC32
□ eDonkey/ eMule

Figure 1 Original Hash Values for ID_Theft.doc

Exercise 3: Using Command Prompt

IP and MAC Addresses for Windows OS

IP (Internet protocol) addresses are not unique to computers. They identify the node. If you switch computers the IP address remains with the node. However, each computer has a unique identifying number called the MAC (media access control) address. In this exercise you will use the Command Prompt to find your IP and MAC addresses.

On your home computer, go to Accessories / Command Prompt

If the cursor is not on the C: directory, enter the following…

CD\
Then enter …
Ipconfig /all
Find the physical address (MAC address) and the IPv4 address and write them down.

Command Prompt and DOS Commands

At the command prompt attempt the following commands. [ ] is for annotation only.

This assumes the file is on your C: drive. If not, then insert the full path to the file.

Enter the following commands

```
C:                                   [this will take you to the c: drive]
TYPE C:\ Shakespeare.txt             [this will type out the contents of the file]
RENAME C:\ Shakespeare.txt WilliamShakespeare.txt   [renames the file]
MD Projects                          [creates a new folder name Projects]
RD Projects                          [removes folder named Projects]
DIR *.*                              [lists all files in the current folder]
DIR C:\Projects\ *.doc               [lists all .doc files in the Projects folder]
```

PrintScreen the CommandPrompt window.
Enter the following command to clear the screen: CLS

Access and Print System Information

Click Start \ Run and type msconfig

In the System Configuration table select Startup and examine what programs are opened when you start your computer. Do you want all of these to open? If not, then deselect the box for unwanted applications.

In the System Configuration table select Tools\Security Center and click Launch. Click Internet Options and explore the trusted certifications.

PrintScreen the System Information for your computer.

Exercise 4: File Signatures

Opening files in either NotePad or a hexadecimal (hex) editor provides initial information for examination of files. The investigator can also determine if the file type is correct. For each file, you will open it in both NotePad and WinHex. In WinHex you will note the first eight bytes in positions 0-7. Each byte will be two characters ranging from 00-FF. These eight bytes often are the signature for the filetype. However, for MS Windows, the signature is the same for Word, Excel and PowerPoint but different for Access. To determine the filetype you must do a find (Ctrl+F) and search for Word, Excel or PowerPoint. Figure 2 shows the first eight bytes for a Word file and the result of a Find operation.

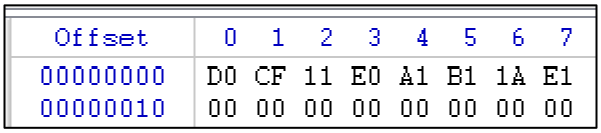
Step 1: Create a work-folder on your personal computer c: drive named Projects.
Step 2: Download and extract the projects.zip from the instructor’s web site.
Step 3: Open the following files in both Notepad and WinHex. Determine the file type for each and indicate how you could identify the file type in Notepad and the hex editor. Simply copy the identifying information into the table. If it does not appear to be identifiable then type NI.

The hex signatures have been completed in the table below.

File	**Filetype**	**NotePad**	**Hex Editor**
Consent_to_Record_Form	.pdf		25 50 44 46 2d 31 2e 34
HxDShotLarge	.png		89 50 4E 47 0D 0A 1A 0A
Sound Enhancer	.gif		47 49 46 38 39 61 90 01
Social Engineering	.doc		DO CF 11 E0 A1 B1 1A E1
Pen Mike	.jpg		FF D8 FF E1 2F FE 45 78
AccountNo2	.txt		54 68 65 20 62 61 6E 6B
Bruce Springsteen	.mp3		49 44 33 03 00 00 00 03
Wildlife	.wmv		B7 D8 00 20 37 49 DA 11

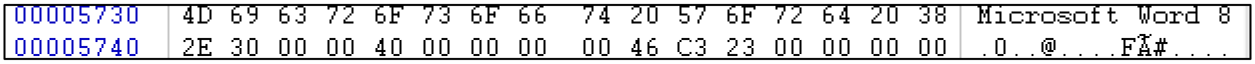
Step 4: Open the Social Engineering file in WinHex and change the first eight bytes to resemble a .jpg file. Save the file and then try to open it. What happens? Open it again in WinHex and change the first eight bytes back to their correct values. Save and re-open. It is now back to its original state. This process allows fraudsters to conceal files in plain sight.

The following signature is the same for MS Windows Excel, Word, and PowerPoint



```
Offset     0  1  2  3  4  5  6  7
00000000  D0 CF 11 E0 A1 B1 1A E1
00000010  00 00 00 00 00 00 00 00
```

The following shows the result of a Find operation for Word in the file. Use the ASCII table to show how Microsoft Word is represented in hex.



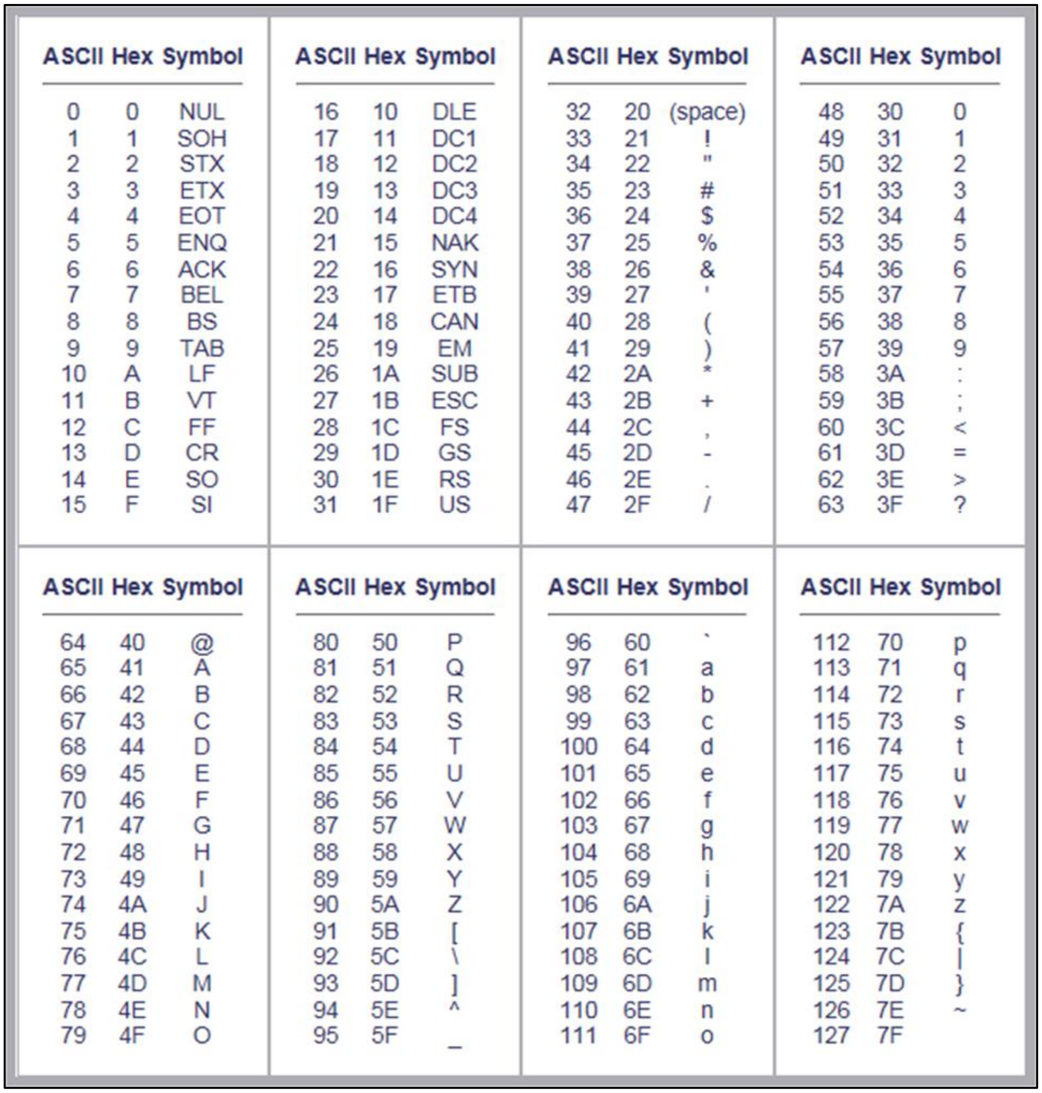
```
00005730  4D 69 63 72 6F 73 6F 66  74 20 57 6F 72 64 20 38  Microsoft Word 8
00005740  2E 30 00 00 40 00 00 00  00 46 C3 23 00 00 00 00  .0..@....FÃ#....
```

Figure 2 File Signature for MS Word, Excel and PowerPoint

Exercise 5: ASCII Codes

ASCII code is used for storage of all text values in personal computers. In ASCII each letter, digit and special character is represented in eight bits or one byte. From the table in Figure 3, verify that you understand the ASCII code by determining the code for each item in the table below. Leave a space between each byte. Note in the first example, the space requires a code.

ITEM	ASCII VALUE IN HEX
MI 5	4D 49 20 35
Microsoft Word	
123 Oak Ave.	
(555) 123-1234	
$50.46	



ASCII	Hex	Symbol	ASCII	Hex	Symbol	ASCII	Hex	Symbol	ASCII	Hex	Symbol
0	0	NUL	16	10	DLE	32	20	(space)	48	30	0
1	1	SOH	17	11	DC1	33	21	!	49	31	1
2	2	STX	18	12	DC2	34	22	"	50	32	2
3	3	ETX	19	13	DC3	35	23	#	51	33	3
4	4	EOT	20	14	DC4	36	24	$	52	34	4
5	5	ENQ	21	15	NAK	37	25	%	53	35	5
6	6	ACK	22	16	SYN	38	26	&	54	36	6
7	7	BEL	23	17	ETB	39	27	'	55	37	7
8	8	BS	24	18	CAN	40	28	(	56	38	8
9	9	TAB	25	19	EM	41	29	)	57	39	9
10	A	LF	26	1A	SUB	42	2A	*	58	3A	:
11	B	VT	27	1B	ESC	43	2B	+	59	3B	;
12	C	FF	28	1C	FS	44	2C	,	60	3C	<
13	D	CR	29	1D	GS	45	2D	-	61	3D	=
14	E	SO	30	1E	RS	46	2E	.	62	3E	>
15	F	SI	31	1F	US	47	2F	/	63	3F	?

ASCII	Hex	Symbol	ASCII	Hex	Symbol	ASCII	Hex	Symbol	ASCII	Hex	Symbol
64	40	@	80	50	P	96	60	`	112	70	p
65	41	A	81	51	Q	97	61	a	113	71	q
66	42	B	82	52	R	98	62	b	114	72	r
67	43	C	83	53	S	99	63	c	115	73	s
68	44	D	84	54	T	100	64	d	116	74	t
69	45	E	85	55	U	101	65	e	117	75	u
70	46	F	86	56	V	102	66	f	118	76	v
71	47	G	87	57	W	103	67	g	119	77	w
72	48	H	88	58	X	104	68	h	120	78	x
73	49	I	89	59	Y	105	69	i	121	79	y
74	4A	J	90	5A	Z	106	6A	j	122	7A	z
75	4B	K	91	5B	[	107	6B	k	123	7B	{
76	4C	L	92	5C	\	108	6C	l	124	7C	|
77	4D	M	93	5D	]	109	6D	m	125	7D	}
78	4E	N	94	5E	^	110	6E	n	126	7E	~
79	4F	O	95	5F	_	111	6F	o	127	7F	

Figure 3 ASCII Code (Source: http://ascii.cl/)

4.3 Computer Forensic Projects

Forensic Project 1: Working with Image Files

A basic tenant of forensic investigations is never work on the original file. First create a mirror image (bit-by-bit copy) and work on the copy. In this exercise the student will image the contents of a USB drive (the suspect drive) and perform a search on the image file.

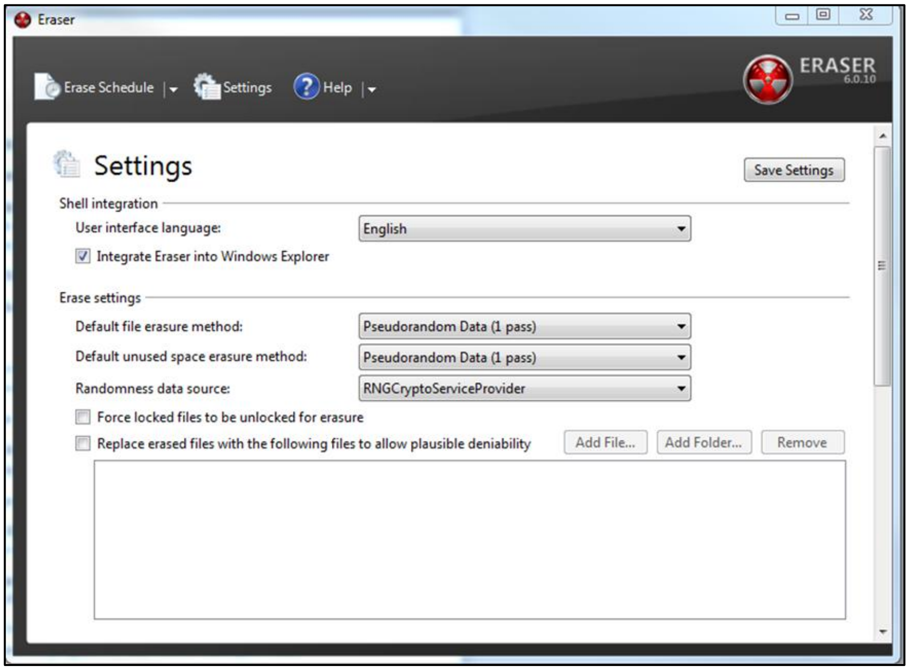
Learning Goal(s): Wiping Disks, Creating a USB Image File; Searching an Image File

Software: Eraser, ProDiscover Basic

Files: Shakespeare, james message, ID Theft, quote1, quote2, AccountNo1, AccountNo2, COSO_COBIT, Social Engineering, Sound Enhancer, Pen Mike, Spy Camera Finder, Consent to Record Form

First, you will delete the files on your USB drive and then add the files you wish to have in your image file. Be sure that you have saved your USB files to another drive.

1. Start Eraser and be sure that the correct drive is selected. In settings, choose those for **Pseudorandom 1 Pass** (see Figure 4). Run Eraser.
2. Copy the above files to your USB drive.
3. Start ProDiscover Basic and click Run Administrator. In the Launch Dialog box, click the New Project tab and enter the project number **Proj01**, and project name **Proj01**.
4. Click **Action** and click Capture **Image**. For Source Drive, select your USB drive. For Destination also select your USB drive. Name the destination file **ForensicProject**. Use your initials for Technician Name and **01** for image number. Click **OK**. This may take several minutes. An image file (**ForensicProject.eve**) will be created which will be a bit-by-bit copy of your USB.
5. Start ProDiscover Basic and click Run Administrator. In the Launch Dialog box, click the New Project tab and enter the project number: Proj01, and project name:
6. Click Action from the menu, point to Add and click Image File.
7. In your work folder, click the file **ForensicProject.eve** and then click Open. If the Auto Image Checksum message box opens, click No (we will not calculate a checksum on this project).
8. In the tree view, click to expand Content View, click to expand Images, and then click the pathname containing your image file. (Files are listed in the work area. See Figure 5).
9. Right-click any file and click View – this will start the associated program such as MS Word or Excel. View the file and then exit the program. Try this with several types of files.
10. To search for the keyword “bank” click the Search toolbar button (the binoculars icon) to open the Search dialog box.
11. Click the **Content Search** tab. If necessary, click the ASCII button and the **Search for the Pattern(s)** option button. Type **bank** in the list box for search keywords. Under Select the Disk/Image(s) click the drive that you are searching and then click **OK**.
12. In the tree view, click to expand Search Results and then click Content Search results to specify the search type and note the search results in Figure 6.
13. To search all clusters, click the **Cluster Search** tab and search for **bank**. This will take more time because all clusters are being searched. Note the results.
14. Save the project. Click File, Save Project from the menu.



Settings

Shell integration

User interface language: English

☑ Integrate Eraser into Windows Explorer

Erase settings

Default file erasure method: Pseudorandom Data (1 pass)

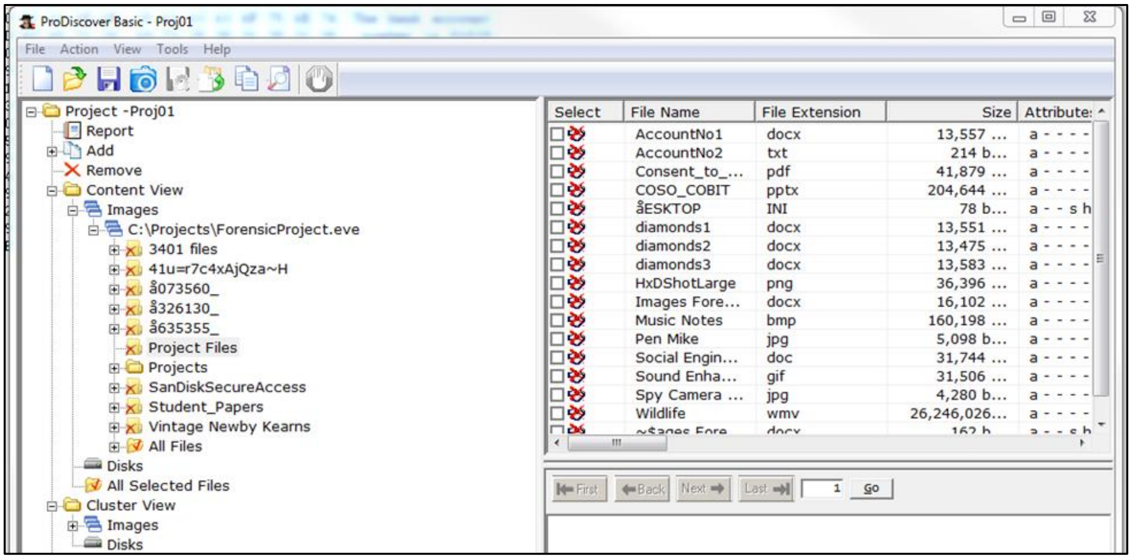
Default unused space erasure method: Pseudorandom Data (1 pass)

Randomness data source: RNGCryptoServiceProvider

☐ Force locked files to be unlocked for erasure

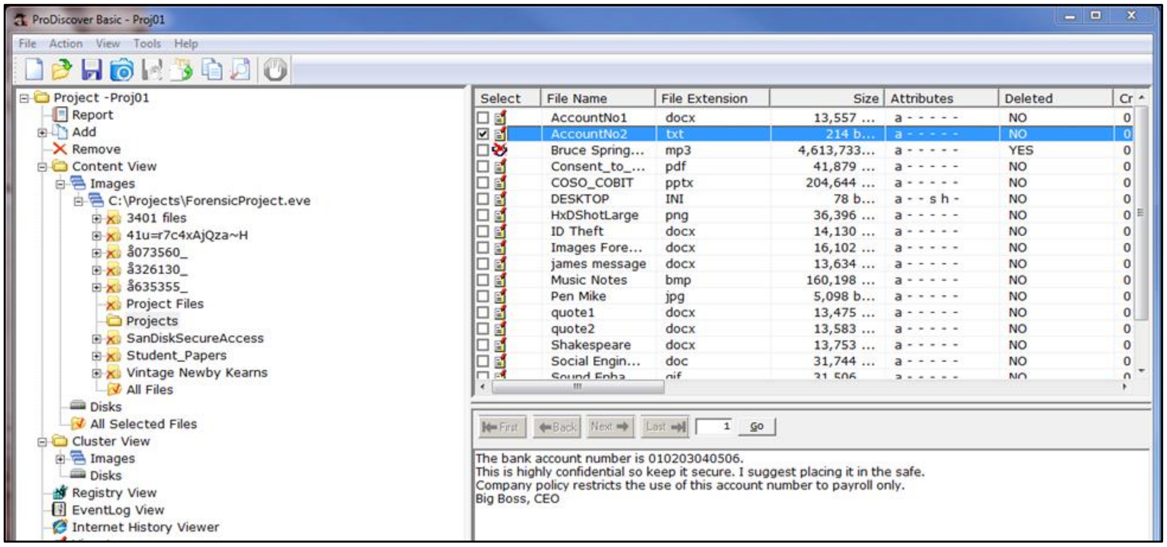
☐ Replace erased files with the following files to allow plausible deniability

Figure 4 Eraser Settings



Select	File Name	File Extension	Size	Attribute:
□	AccountNo1	docx	13,557 ...	a - - - -
□	AccountNo2	txt	214 b...	a - - - -
□	Consent_to_...	pdf	41,879 ...	a - - - -
□	COSO_COBIT	pptx	204,644 ...	a - - - -
□	åESKTOP	INI	78 b...	a - - s h
□	diamonds1	docx	13,551 ...	a - - - -
□	diamonds2	docx	13,475 ...	a - - - -
□	diamonds3	docx	13,583 ...	a - - - -
□	HxDShotLarge	png	36,396 ...	a - - - -
□	Images Fore...	docx	16,102 ...	a - - - -
□	Music Notes	bmp	160,198 ...	a - - - -
□	Pen Mike	jpg	5,098 b...	a - - - -
□	Social Engin...	doc	31,744 ...	a - - - -
□	Sound Enha...	gif	31,506 ...	a - - - -
□	Spy Camera ...	jpg	4,280 b...	a - - - -
□	Wildlife	wmv	26,246,026...	a - - - -

Figure 5 Expanded Path in Content View



Select	File Name	File Extension	Size	Attributes	Deleted	Cr
□	AccountNo1	docx	13,557 ...	a - - - - -	NO	0
☑	AccountNo2	txt	214 b...	a - - - - -	NO	0
□	Bruce Spring...	mp3	4,613,733...	a - - - - -	YES	0
□	Consent_to_...	pdf	41,879 ...	a - - - - -	NO	0
□	COSO_COBIT	pptx	204,644 ...	a - - - - -	NO	0
□	DESKTOP	INI	78 b...	a - - s h -	NO	0
□	HxDShotLarge	png	36,396 ...	a - - - - -	NO	0
□	ID Theft	docx	14,130 ...	a - - - - -	NO	0
□	Images Fore...	docx	16,102 ...	a - - - - -	NO	0
□	james message	docx	13,634 ...	a - - - - -	NO	0
□	Music Notes	bmp	160,198 ...	a - - - - -	NO	0
□	Pen Mike	jpg	5,098 b...	a - - - - -	NO	0
□	quote1	docx	13,475 ...	a - - - - -	NO	0
□	quote2	docx	13,583 ...	a - - - - -	NO	0
□	Shakespeare	docx	13,753 ...	a - - - - -	NO	0
□	Social Engin...	doc	31,744 ...	a - - - - -	NO	0

The bank account number is 010203040506.
This is highly confidential so keep it secure. I suggest placing it in the safe.
Company policy restricts the use of this account number to payroll only.
Big Boss, CEO

Figure 6 Search for the Term "Bank"

Forensic Project 2

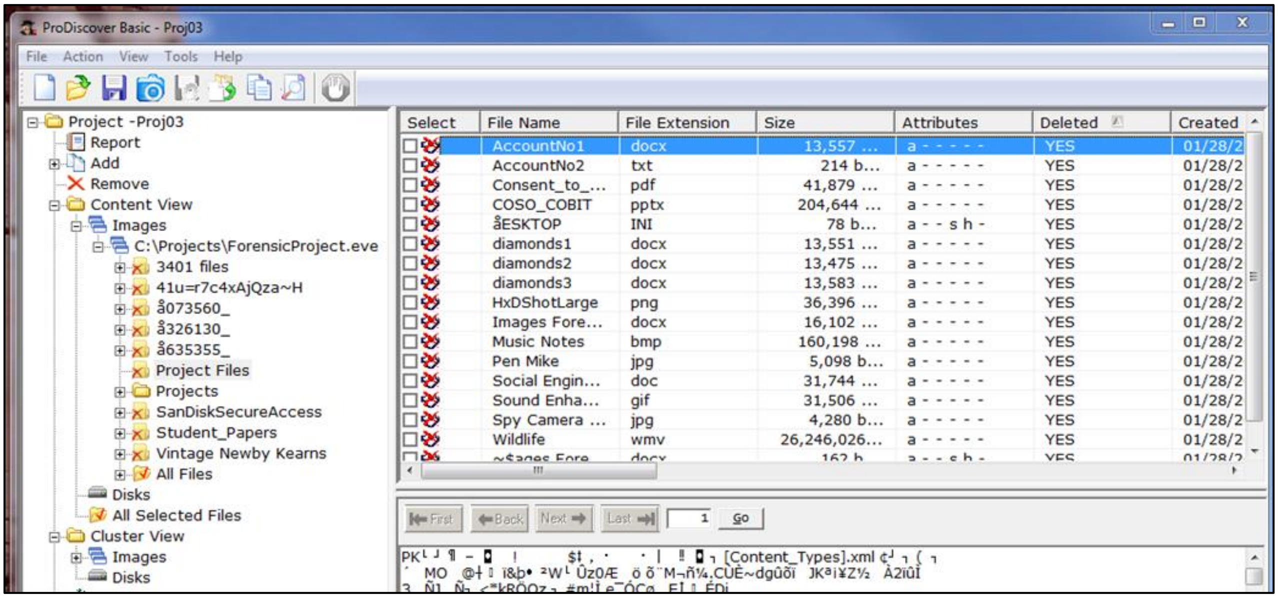
Learning Goals: Search a Unix .dd image file for hidden account numbers

Software: ProDiscover Basic

Files: RawFormat.dd

1. Start ProDiscover Basic and click **Run Administrator**. In the Launch Dialog box, click the New Project tab and enter the project number Proj02, and project name Proj02. Click **File**, **Save Project**.
2. Click **Action** from the menu, point to **Add** and click **Image File**.
3. In your work folder, click the file **RawFormat.dd** and then click Open. If the Auto Image Checksum message box opens, click **No** (we will not calculate a checksum on this project). Note that this is a Unix .dd image file.

4. In the tree view, click to expand **Content View**, click to expand **Images**, and then click the pathname containing your image file. (Files are listed in the work area.)
5. Click View, Gallery View. Scroll through the graphics files on the drive image. To discover the account numbers you will have to inspect each of these files. In the Add Comment dialog box enter a brief comment and click **OK**. This will add your case notes to the ProDiscover reports.
6. For each file of interest, open the file click the Search toolbar button (the binoculars icon) to open the Search dialog box.
7. Click the **Content Search** tab. If necessary, click the ASCII button and the Search for the Pattern(s) option button. Type the account number **0102030405** in the list box for search keywords. Under Select the Disk/Image(s) click the drive that you are searching (see Figure7) and then click **OK**.
8. In the tree view, click to expand Search Results and then click Content Search results to specify the search type and note the search results.
9. To search all clusters, click the **Cluster Search** tab and repeat the search using the account number **0102030405** as the search keyword. Enter notes in the Add Comment dialog box when your search is successful.
10. Click **Report** in the tree view and review the report to insure it is complete. A complete and concise report is critical to the forensic investigation.
11. Click the **Export** toolbar button. In the dialog box click the **RTF Format** button (for rich text) and type **Bank Account Report** in the File Name text box, and then click **OK**. You have now saved the project report.



Select	File Name	File Extension	Size	Attributes	Deleted	Created
□	AccountNo1	docx	13,557 ...	a - - - - -	YES	01/28/2
□	AccountNo2	txt	214 b...	a - - - - -	YES	01/28/2
□	Consent_to_...	pdf	41,879 ...	a - - - - -	YES	01/28/2
□	COSO_COBIT	pptx	204,644 ...	a - - - - -	YES	01/28/2
□	åESKTOP	INI	78 b...	a - - s h -	YES	01/28/2
□	diamonds1	docx	13,551 ...	a - - - - -	YES	01/28/2
□	diamonds2	docx	13,475 ...	a - - - - -	YES	01/28/2
□	diamonds3	docx	13,583 ...	a - - - - -	YES	01/28/2
□	HxDShotLarge	png	36,396 ...	a - - - - -	YES	01/28/2
□	Images Fore...	docx	16,102 ...	a - - - - -	YES	01/28/2
□	Music Notes	bmp	160,198 ...	a - - - - -	YES	01/28/2
□	Pen Mike	jpg	5,098 b...	a - - - - -	YES	01/28/2
□	Social Engin...	doc	31,744 ...	a - - - - -	YES	01/28/2
□	Sound Enha...	gif	31,506 ...	a - - - - -	YES	01/28/2
□	Spy Camera ...	jpg	4,280 b...	a - - - - -	YES	01/28/2
□	Wildlife	wmv	26,246,026...	a - - - - -	YES	01/28/2
□	~$ages Fore	docx	162 b	a - - s h -	YES	01/28/2

```
PKᴸ ┘ ¶ – ▮   !        $ǂ ,  ·      · |   ‼ ▮ ┐ [Content_Types].xml ¢┘ ┐ ( ┐
´  MO  @ǂ ▯  ï&þ• ²Wᴸ Ûz0Æ   ö õ¨M¬ñ¼.CÙÈ~dgûõï  JKªi¥Z½   À2ïûÌ
```

Figure 7 Image File Displayed in Work Area

Forensic Project 3

Learning Goals: Extract allocated files and unallocated files separately

Software: ProDiscover Basic

Files: ForensicProject.eve

1. Start ProDiscover Basic and click **Run Administrator**. In the Launch Dialog box, click the New Project tab and enter the project number Proj03 and project name Proj03. Then click **Open**.

2. In the tree view, click to expand **Add**, click **Image File**. In your work folder, click the **ForensicProject.eve** file and then click **Open** and click **No** in the Auto Image Checksum message box. Save the project to your folder.
3. In the tree view, click to expand **Content View**, click to expand **Images**, and then click the pathname containing the image file. Examine the files displayed in the work area. Under the column heading **Deleted** note that the files are either YES (indicating deleted or unallocated files) or NO (indicating active or allocated files).
4. Sort on the Deleted column by clicking the Deleted header.
5. To extract the **allocated files**, right-click each of the files designated as NO in the Deleted Column and click **Copy File**. In ProDiscover Basic this must be performed for each separate file.
6. To extract the **unallocated files**, right-click each of the files designated as YES in the Deleted Column and click **Copy File**. As you click a check-box, the Add Comment dialog box appears. Note the filename and type that has been deleted. (In practice, you would first examine each of these files and add a meaningful comment.)

Forensic Project 4

This project creates two desk-top icons that enable or disable writing to USB devices. Students are advised to create a **system restore point** before attempting this project.

Learning Goals: Modify the MS Windows Registry; Create a USB Write-Blocker

1. **Software:** MS Windows Regedit
1. In the MS Windows Start Search text box, type **regedit** and press **Enter**. This opens the Registry Editor from which you can access system folders and files.
2. In the editor, browse to and click to expand the **\HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet** key.
3. Right-click the **Control** subkey, click **New**.
4. The Registry Editor prompts the user for a key name. Enter **USBDevicePolicy** and press **Enter**. This creates a descendant key.
5. Right-click the **USBDevicePolicy** key, point to **New**, and click **DWORD Value**. If you have an option for 32-bit or 64-bit, click 32-bit.
6. In the prompt, type WriteProtect and press Enter.
7. In the key data area, right-click **WriteProtect DWORD** (or just WriteProtect) and click **Modify.**
8. In the Edit DWORD Value dialog box, change the Value Data setting from 0 to 1, and then click OK to activate write-blocking to USB devices.
9. Right-click the **USBDevicePolicy** descendant key and click **Export**.
10. In the Export Registry File dialog box, click Desktop in the Save in list box. In the filename text box, type **Write Protect USB ON**, and click **Save**.
11. In the registry editor, click **USBDevicePolicy**. In the key data area, right-click **WriteProtect DWORD** and click **Modify.**
12. In the Edit DWORD Value dialog box, change the Value Data setting from 1 to 0 and click **OK** to deactivate write-blocking to USB devices.
13. Right-click **USBDevicePolicy** descendant key again and click Export.
14. In the Export Registry File dialog box, click Desktop in the Save in list box. In the File name text box, type **Write Protect USB OFF**, and click **Save**. Close the registry editor.

Forensic Project 5

Learning Goals: Restore an image file to a drive using the UNIX dd format for raw acquisition.

Software: ProDiscover Basic

Files: ForensicProject.eve

1. Transfer the data from the **ForensicProject.eve** file to the target drive (USB drive). Connect a USB drive to the workstation. Smaller USB drives work best as this exercise writes to the entire drive. I suggest 100-500 MB if available.
2. Start ProDiscover Basic and click **Tools**, **Copy Disk**.
3. In the dialog box click the Image to Disk tab.
4. From the work folder, click the **ForensicProject.eve** file and then click **Open**.
5. In the Copy source disk dialog box click in the area below Disk Name.
6. Click the Disk Name list arrow and then click the target drive, then click **OK**.
7. In the dialog box that opens click **Write all 0's** and then click **OK**. This begins the data loading and fills the remainder of the drive with 0's.
8. In the completion dialog box click OK to terminate loading.
1. Now you will use the raw acquisition format for creating an image file.
9. On your workstation click the **Write Protect USB ON** icon that you created earlier. This will protect the acquisition drive. Click **Yes** and then **OK** in the confirmation dialog boxes.
10. In ProDiscover Basic click **Action**, **Capture Image** from the menu.
11. In the dialog box, click the **Source Drive** list arrow and then click P**hysicalDrive1**.
12. Next to the Destination text box, click the >> button and in the Save As dialog box navigate to the work folder and click **Save**.
13. In the **Capture Image** dialog box click the **Image Format** list arrow and click **UNIX style dd** format (for a raw acquisition). Click **OK** to start the acquisition and then click **Proceed** in the warning box. When the acquisition is complete click **OK** in the message box. The raw format creates the acquired file (.dd), a log file (.pds) and a hash file (.md5).
14. Click the **Write Protect USB OFF** button on the workstation desktop and remove the USB. Exit ProDiscover Basic. The suspect files are now imaged on the workstation in UNIX dd format.

Forensic Project 6

Learning Goals: How to locate time and date information from metadata; How to identify file fragments found in the MFT records which could be found in unallocated disk space or the Pagefile.sys.

Software: ProDiscover Basic

1. Open Notepad and create a text file with the message: Not even computers will replace committees because committees buy computers. Save the file in the work folder as **ForensicProj06A.txt**. Exit Notepad.
2. Start ProDiscover Basic and begin a new project ForProj01A. Click **Action** and then **Add**.
3. In the Add Disk to Project dialog box click **PhysicalDrive0**. Type **c-drive** in the text box and click **Add**. If there is a warning message, click **OK**.
4. In the tree view, click to expand **Content View**, **Disks**, and **PhysicalDrive0**. Then click the **C** drive.
5. If necessary scroll down in the work area and right-click $MFT and click Copy File. In the Save As dialog box, save the file to the work folder. Exit ProDiscover Basic.
6. Start the WinHex hex editor by clicking **Start**, **All Programs**, **WinHex**. If there is a warning message box, click **OK**.
7. On the toolbar click **Open** and navigate to the workfolder. Click the **$MFT** file and then **Open**.
8. On the menu, click **Search**, **Find Text**.
9. In the text box for specifying a search string type **ForensicProj06A.txt.** Click the **Format Code** arrow, click **Unicode** and then click **OK**.

10. Right-click the **Data Interpreter** window and click **Options**. In the dialog box, click the **Win32 FILETIME** (64 bit) check box and then click **OK**.
11. Scroll up so that the MFT record label FILE for **ForensicProj06A.txt** is the first line at the top of the hexadecimal and text displays.
12. Click at the beginning of the record, on the letter F in FILE, and then drag down and to the right while you watch the hex counter in the lower-right corner. When the counter reaches 50 release the mouse button.
13. Move the cursor to the next byte (one position to the left) and record the date and time of the Data Interpreter's FILETIME values.
14. Exit WinHex.

Forensic Project 7

Learning Goals: Conducting a keyword search

Software: AccessData FTK

1. Start AccessData FTK. Create a new case called **ForProj08** for the case name and number. Click **Next** until the **Add Evidence** and **Case** dialog box appear.
2. Click **Add Evidence**, click **Local Drive** and then click **Continue**.
3. Insure that your USB drive (or local disk drive) and **Logical Analysis** are selected and then click **OK**.
4. In the Evidence Information dialog box click to select your time zone and then click **OK**. Click **Next** and then click **Finish**. FTK will process the files and then indicate the evidence items.
5. Click **Search**, **Tools**, **Analysis Tools** from the menu, click to select the **Full Text Indexing** check box and then click OK.
6. In the search term text box type **Diamond** and then click **Add**. Click the **View Cumulative Results** button and then click **OK** in the Filter Search Hits dialog box. Repeat the search for the terms **Gold**, and **Silver**. The number of hits or occurrences of the search terms will appear under Search Items. (This will not include the items in the file slack space.)
7. Click **Overview**, **Documents** and then click. Scroll the upper-right pane until you see the word '**Diamond**'. Note the logical sector position at the bottom of the upper-right pane.
8. Click the **Search** tab and then click **Live Search**. In the text box, type **Diamond** and make sure that **ASCII** and **UNICODE** are selected. Click **Add** and then the **Search** button, select **All Files** option and then click **OK**. When the search is complete click **View Results** to see the information displayed at the upper-right.
9. Click the expand (+) buttons to find the search results. Scroll in the middle pane until you find 'Diamonds'.
10. Repeat steps 8 and 9 for 'Gold.'
11. The bottom pane displays details about the data FTK found including each occurrence of the word. Close FTK.

Forensic Project 8

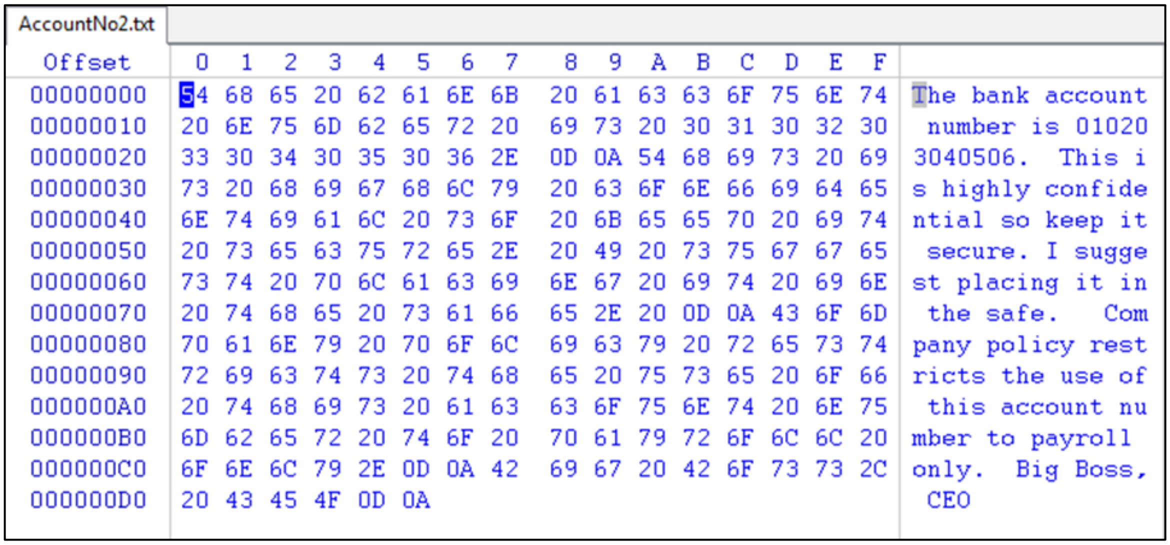
One way of hiding information is to place the information in a file using a hex editor and corrupt the file so that it cannot be opened or, when opened, presents garbled data. This can be performed by simply rotating the bits in the file. To repair the file, simply rotate the bits back to their previous position.

Learning Goals: Bit shifting and rotation.

Software: AccessData FTK

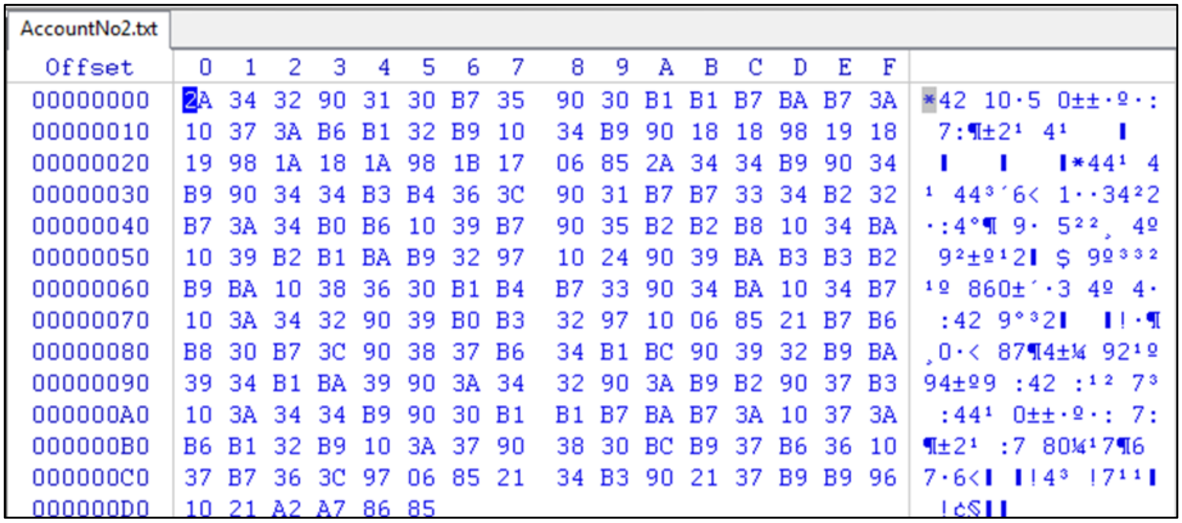
Files: AccountNo2.txt

1. Start WinHex and open the file codes.txt.
2. Move the cursor over the toolbar buttons for Shift Left, Shift Right and note that Rotate Left, Rotate Right, Block Shift Left and Block Shift Right are also available. Click Rotate Right and create a screen print of the results for later comparison. Assume that the data is ordered in little endian. Then click OK.
3. Click **Rotate Left**. In the **Rotate Left Operation** dialog box insure that the settings are the same as in the **Treat Data As for Rotate Right**. Otherwise, the bits will not be shifted equally. Save the file but do not close.
4. Click **Shift Right** and click **OK** <u>twice</u> and note what is happening with the data.
5. Click **Block Shift Left**. Attempt to reverse the procedure by clicking **Block Shift Right**, click **Shift Left** <u>twice</u> and click **OK** as needed.
6. Note that the data is garbled and the procedure has not been reversed. A shift (nonrotated) operation simply drops the bits as they are moved to the right or left and they cannot be recovered. Close the file but do not save. See Figures 8 and 9.



```
AccountNo2.txt
  Offset    0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
 00000000  54 68 65 20 62 61 6E 6B  20 61 63 63 6F 75 6E 74  The bank account
 00000010  20 6E 75 6D 62 65 72 20  69 73 20 30 31 30 32 30   number is 01020
 00000020  33 30 34 30 35 30 36 2E  0D 0A 54 68 69 73 20 69  3040506.  This i
 00000030  73 20 68 69 67 68 6C 79  20 63 6F 6E 66 69 64 65  s highly confide
 00000040  6E 74 69 61 6C 20 73 6F  20 6B 65 65 70 20 69 74  ntial so keep it
 00000050  20 73 65 63 75 72 65 2E  20 49 20 73 75 67 67 65   secure. I sugge
 00000060  73 74 20 70 6C 61 63 69  6E 67 20 69 74 20 69 6E  st placing it in
 00000070  20 74 68 65 20 73 61 66  65 2E 20 0D 0A 43 6F 6D   the safe.  Com
 00000080  70 61 6E 79 20 70 6F 6C  69 63 79 20 72 65 73 74  pany policy rest
 00000090  72 69 63 74 73 20 74 68  65 20 75 73 65 20 6F 66  ricts the use of
 000000A0  20 74 68 69 73 20 61 63  63 6F 75 6E 74 20 6E 75   this account nu
 000000B0  6D 62 65 72 20 74 6F 20  70 61 79 72 6F 6C 6C 20  mber to payroll
 000000C0  6F 6E 6C 79 2E 0D 0A 42  69 67 20 42 6F 73 73 2C  only.  Big Boss,
 000000D0  20 43 45 4F 0D 0A                                  CEO
```

Figure 8 File Before Bit Shifting



```
AccountNo2.txt
  Offset    0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
 00000000  2A 34 32 90 31 30 B7 35  90 30 B1 B1 B7 BA B7 3A  *42 10·5 0±±·º·:
 00000010  10 37 3A B6 B1 32 B9 10  34 B9 90 18 18 98 19 18   7:¶±2¹ 4¹    ▌
 00000020  19 98 1A 18 1A 98 1B 17  06 85 2A 34 34 B9 90 34  ▌   ▌   ▌*44¹ 4
 00000030  B9 90 34 34 B3 B4 36 3C  90 31 B7 B7 33 34 B2 32  ¹ 44³´6< 1··34²2
 00000040  B7 3A 34 B0 B6 10 39 B7  90 35 B2 B2 B8 10 34 BA  ·:4°¶ 9· 5²²¸ 4º
 00000050  10 39 B2 B1 BA B9 32 97  10 24 90 39 BA B3 B3 B2   9²±º¹2▌ $ 9º³³²
 00000060  B9 BA 10 38 36 30 B1 B4  B7 33 90 34 BA 10 34 B7  ¹º 860±´·3 4º 4·
 00000070  10 3A 34 32 90 39 B0 B3  32 97 10 06 85 21 B7 B6   :42 9°³2▌  ▌!·¶
 00000080  B8 30 B7 3C 90 38 37 B6  34 B1 BC 90 39 32 B9 BA  ¸0·< 87¶4±¼ 92¹º
 00000090  39 34 B1 BA 39 90 3A 34  32 90 3A B9 B2 90 37 B3  94±º9 :42 :¹² 7³
 000000A0  10 3A 34 34 B9 90 30 B1  B1 B7 BA B7 3A 10 37 3A   :44¹ 0±±·º·: 7:
 000000B0  B6 B1 32 B9 10 3A 37 90  38 30 BC B9 37 B6 36 10  ¶±2¹ :7 80¼¹7¶6
 000000C0  37 B7 36 3C 97 06 85 21  34 B3 90 21 37 B9 B9 96  7·6<▌ ▌!4³ !7¹¹▌
 000000D0  10 21 A2 A7 86 85                                  !¢§▌▌
```

Figure 9 File After Bit Shifting

5. DISCUSSION AND CONCLUSIONS

This paper addresses the need for computer forensics education for accounting students. While the forensic accounting profession continues to grow, most accounting students do not have exposure to a class in computer forensics. To be effective, it is essential that forensic accountants be knowledgeable of and able to apply basic computer forensic skills. The purpose of this paper is to present the educator with a number of exercises and projects that provide the accounting student with skills important to careers as forensic accountants and IT auditors. While students may not emerge from this course as experts in computer forensics they would develop and important competence that would benefit the organization. These skills could be extended in a variety of ways through pursuing advanced education in college courses, workshops and self-study tutorials.

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