A Risk Mitigation Model: Lessons Learned From Actual Insider Sabotage

Dawn M. Cappelli, Andrew P. Moore, Eric D. Shaw

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**A Risk Mitigation Model: Lessons Learned From Actual Insider Sabotage**

**Performing Organization Name(s) and Address(es)**
Carnegie Mellon University, Software Engineering Institute (SEI), Pittsburgh, PA, 15213

**Sponsoring/monitoring agency name(s) and address(es)**

**Abstract**

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**Supplementary Notes**

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November 7, 2006
Financial Institution Discovers $691 Million in Losses...

Covered up for 5 Years by Trusted Employee
Manufacturer Loses $10 Million—Lays Off 80 Employees...

Sabotage by Employee of Eleven Years Nearly Puts Company Out of Business
COULD THIS HAPPEN TO YOU?
Agenda

Introductions

Background
  • Evolution of CERT’s Insider Threat Research
  • Simultaneous PERSEREC Insider Threat Research

Interactive Case Example

Key Insider IT Sabotage Observations
  • Case Examples
  • Statistics
  • Observables

MERIT Model Overview

Best Practices

Future Work
Introductions
What is CERT?

Center of Internet security expertise

Established by the US Department of Defense in 1988 on the heels of the Morris worm that created havoc on the ARPANET, the precursor to what is the Internet today

Located in the Software Engineering Institute (SEI)

- Federally Funded Research & Development Center (FFRDC)
- Operated by Carnegie Mellon University (Pittsburgh, Pennsylvania)
Background
Evolution of CERT Insider Threat Research

Insider threat case studies

- U.S. Department Of Defense Personnel Security Research Center (PERSEREC)
- CERT/U.S. Secret Service *Insider Threat Study*

Best practices

- Carnegie Mellon CyLab *Common Sense Guide to Prevention and Detection of Insider Threats*

System dynamics modeling

- Carnegie Mellon CyLab – *Management and Education on the Risk of Insider Threat (MERIT)*
- PERSEREC
Simultaneous PERSEREC Insider Threat Research

Small number of cases (10)
In-depth Personal, Organizational Psychological Perspective
Emphasis on experience of individual by those in workplace as he moves from disgruntlement to attack
Results Available (Shaw and Fischer, 2005; Shaw, 2006)
Similar Findings to CERT
CERT/USSS Insider Threat Study

Definition of insider:

Current or former employees or contractors who

- intentionally exceeded or misused an authorized level of access to networks, systems or data in a manner that

- targeted a specific individual or affected the security of the organization’s data, systems and/or daily business operations
Insider Threat Study

Funded by US Secret Service (partially by Department of Homeland Security)

Big picture approach: examine technical & psychological aspects of the problem

Objective: Analyze actual cases to develop information for prevention & early detection

Methodology:

• Collected cases (150)
• Codebooks
• Interviews
• Reports
• Training
Management and Education of the Risk of Insider Threat

Funded by CyLab

Develop models of insider IT sabotage

Communicate the multi-disciplinary nature of problem
  • Problem and mitigation requires analysis of policies, practices, technologies over time

Develop innovative training materials

Help organizations understand how they need to work across departments to mitigate the insider sabotage risk
  • May require mental model shift, culture change
2006 e-Crime Watch Survey

CSO Magazine, USSS & CERT
434 respondents

Percentage of Incidents With no Source Identified

Percentage of insiders versus outsiders
Percentage of Participants Who Experienced an Insider Incident (2004-2006)
Overview of Insider Crimes
Types of Insider Crimes

**Fraud:** obtaining property or services from the organization unjustly through deception or trickery.

**Theft of Information:** stealing confidential or proprietary information from the organization.

**IT Sabotage:** acting with intention to harm a specific individual, the organization, or the organization’s data, systems, and/or daily business operations.
Insider Threat Study Case Breakdown

IT Sabotage: 54
Fraud: 44
Theft of IP: 40

116 cases total
Typical Fraud Incidents

Who were they?
- Current employees
- Half male; half female
- Non-technical; non-management positions

Why did they do it?
- Greed

How did they attack?
- Many had privileged access
- Only legitimate user commands
- Used their own username & password
- Acted during working hours from within the workplace
Typical Fraud Incidents - 2

How was it detected?
- System irregularity
- Non-technical means

How was the insider identified?
- System logs

What were the impacts?
- Financial impacts to employer
- Impacts to innocent victims
Typical Theft of Confidential Information Incidents

Who were they?
- Current employees (but almost half of them had already accepted another position)
- Male
- Over half held technical positions

Why did they do it?
- Financial
- Entitlement (some didn’t realize it was wrong)
- Disgruntled

How did they attack?
- Used their own username & password, but half also compromised an account
- Acted during working hours from within the workplace
Typical Theft of Confidential Information Incidents - 2

How was it detected?
• Non-technical means
• Half by system irregularity

How was the insider identified?
• System logs

What were the impacts?
• Financial impacts to employer
• Organization & customer confidential information revealed
• Trade secrets stolen
• Innocent victim murdered
• Insider committed suicide
Typical IT Sabotage Attack

Who were they?
- Former employees
- Male
- Highly technical positions

Why did they do it?
- Disgruntled
- Revenge for negative work-related event

How did they attack?
- No authorized access
- Backdoor accounts, shared accounts, other employees’ accounts, insider’s own account
- Many technically sophisticated
- Remote access outside normal working hours
Typical IT Sabotage Attack - 2

How was it detected?
- Manually by non-security personnel
- System failure or irregularity

How was the insider identified?
- System logs
- Most took steps to conceal identity and/or actions

What were the impacts?
- Inability to conduct business, loss of customer records, inability to produce products
- Negative media attention
- Private information forwarded to customers, competitors, or employees
- Exposure of personal or confidential information
- Web site defacements
- Many individuals harmed
Insider Case Exercise
Ian Archer’s Attack of iAssemble, Inc.

We will hand out a description of a fictional but representative case.

Please take a few minutes to review the case description.

We will be leading an interactive discussion of this case.
iAssemble Case Timeline

1997
iAssemble established – Eagles and Thompson partners, and Archer employed
Archer builds network and computing support for critical iAssemble processes

Fall 2000
Archer’s father diagnosed with lung cancer
Archer looses driver’s license for DUI

Winter 2000-2001
Adams hired as lead administrator
Archer moves all programs off of local workstations and onto central server
Allen hired as junior administrator to work with Archer
Archer tests malicious program four times at work on test server
iAssemble Case Timeline (cont.)

Spring 2001
Allen shares password with Archer
Formal complaint filed by coworker against Archer for harassment
Archer reprimanded

Summer 2001
Archer begins interviewing for other jobs
Archer creates backdoor; intimidates coworker out of backup tapes
Archer fired; remote access via Allen’s account; logic bomb planted via backdoor
Law enforcement brought in; forensics examination started

Aftermath
Questions & Discussion
Questions about Case

Why did Archer attack iAssemble?

Why was Archer able to harm iAssemble’s systems after firing?

What could iAssemble have done to prevent the attack?

What should iAssemble do in the future?
Why did Archer attack iAssemble?
Key Concepts

Unmet expectation as origin of disgruntlement

- What can cause expectation to grow?

- What other types of unmet expectation might lead to disgruntlement?

Predisposition to attack

- What personal risk factors might have indicated that Archer was predisposed to attack?
Why was Archer able to harm iAssemble after firing?
Key Concepts

Access path

- A sequence of one or more access points that lead to a critical system

*An organization may not know about all of the access paths to its critical systems.*
What could iAssemble have done to prevent the attack?
Key Concepts

Behavioral precursors

- Actions (offline) by the insider that might indicate an increased risk of cyber attack

Technical precursors

- Online actions by the insider that might involve setting up the attack
What should iAssemble do in the future?
iAssemble Case Summary
Questions about Case

Why did Archer attack iAssemble?

Why was Archer able to harm iAssemble’s systems after firing?

What could iAssemble have done to prevent the attack?

What should iAssemble do in the future?
iAssemble Case Lessons (Behavioral)

Management should recognize potential impact of negative work-related events, e.g.

- New supervisor
- Layoffs
- Start or end of new project
- Change in salary/bonus structure

Management must be alert for behavioral precursors

Management should increase auditing and monitoring for technical preparatory actions

Bottom line: Management must understand and pay attention to the conditions that increase risk of insider threat.
iAssemble Case Lessons (Technical)

Management must recognize technical precursors
Ability to disable access must be on-demand and absolute (particularly for system administrators & privileged users)
  - Negative events like demotion and firing are critical points
But this is often easier said than done
  - Disabling access requires management to understand access paths available to insider
    - Management’s understanding depends on rigorous access management practices
  - Practices tend to degrade over time without regular reinforcement
    - It takes time to recover from poor access management practices
Bottom line: Proactive, ongoing access management needed
Management and Education of the Risk of Insider Threat

Funded by CyLab

Develop models of insider IT sabotage

Communicate the multi-disciplinary nature of problem
  • Problem and mitigation requires analysis of policies, practices, technologies over time

Develop innovative training materials

Help organizations understand how they need to work across departments to mitigate the insider sabotage risk
  • May require mental model shift, culture change
Definition of Insider IT Sabotage

Cases

- across critical infrastructure sectors
- in which the insider’s primary goal was to
  - sabotage some aspect of an organization or
  - direct specific harm toward an individual(s).
Summary of Sabotage Crimes

- Constructed or downloaded, tested, planted logic bomb
- Deleted files, databases, or programs
- Destroyed backups
- Revealed derogatory, confidential, or pornographic information to customers, employees, or public
- Modified system or data to present pornography or embarrassing info
- Denial of Service by modifying authentication info, deleting data, or crashing systems
- Modified system logs to frame supervisor or innocent person & conceal identity
- Downloaded customer credit card data & posted to website
- Cut cables
- Sabotaged own project
- Physically stole computers and/or backups
- Planted virus on customers’ computers
- Extortion for deleted data & backups
- Defaced organization’s website
- Listed person as deceased in federal government database
Key Insider IT Sabotage Observations
Definition of Insider IT Sabotage

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• across critical infrastructure sectors
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Insider Threat Study Case Breakdown

IT Sabotage: 54
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116 cases total
Who Were the Saboteurs?

Age: 17 – 60

Gender: mostly males

Variety of racial & ethnic backgrounds

Marital status: fairly evenly split married versus single

Almost 1/3 had previous arrests
Observation #1:

Most insiders had personal predispositions that contributed to their risk of committing malicious acts.
Personal Predispositions

- Serious mental health disorders
- Personality problems
- Social skills and decision-making biases
- History of rule conflicts
Serious Mental Health Disorders

A diagnosed mental health problem for which treatment was recommended or sought.

Examples:

- Treated with anti-anxiety and anti-depressant medications
- Alcohol and drug addiction
- Panic attacks
- Mental health treatment for stress
- Physical spouse abuse
- Seizure disorder
- Examples: “Bill” and “Archer”
Personality Problems

Biased views of self and others that cause maladaptive relations. Examples:

- Sensitivity to criticism & needs for attention
- Chronic frustration & feeling unappreciated
- Difficulties controlling anger with bursts of inappropriate temper
- Chronic sense of victimization or mistreatment
- Chronic grudges against others
- Grandiose/above the rules
- Subject is avoided by others or they “walk on eggshells” around him or her
- Bragging, bullying, spending on fantasy-related items
- Compartmentalizes
- Lack of conscience, impulse control, empathy for others, social impact
- Example: CTO
Social skills and Decision-Making Biases

Chronic withdrawal or conflicts with fellow workers, supervisors and security personnel.

Examples:
- Bullying and intimidation of fellow workers
- Refusal to confront supervisors with legitimate work-related complaints due to shyness while complaining to competitors
- Serious personality conflicts
- Unprofessional behavior
- Personal hygiene problems
- Inability to conform to rules
- Example: Silent hacker
History of Rule Violations

Past legal, security, or procedural violations.

Examples:

- Arrests
- Hacking
- Security violations
- Harassment or conflicts resulting in official sanctions or complaints
- Misuse of travel, time, expenses
- Example: Heavy metal
Case Example – Observation #1

A database administrator wipes out critical data after her supervisor and coworkers undermine her authority.
Personal Predispositions

- Exhibited: 60%
- Unknown: 40%
Observation #2:

Most insiders’ disgruntlement is due to unmet expectations.
Case Example – Observation #2

A network engineer retaliates after his hopes of recognition and technical control are dashed.
Unmet Expectations

** Data was only available for 25 cases
Unmet Expectations Observed in Cases

Salary/bonus
Promotion
Freedom of online actions
Use of company resources
Privacy
Work ethic
Authority/Responsibilities
Project requirements - deadlines, milestones
Job dissatisfaction
Supervisor demands
Coworker relations
Overestimated abilities
Access to information following termination

Unmet Expectations Generated by Personal Predispositions
Observation #3:

In most cases, stressors, including sanctions and precipitating events, contributed to the likelihood of insider IT sabotage.
A disgruntled system administrator strikes back after his life begins to fall apart personally and professionally.
Stressors /Sanctions/Precipitating Events

Unknown

3%

Stressors/Sanctions/
Precipitating Events

97%
### Stressors/Sanctions/Precipitating Events Observed in Cases

<table>
<thead>
<tr>
<th>Terminations</th>
<th>Sanctions</th>
<th>Financial</th>
</tr>
</thead>
<tbody>
<tr>
<td>gross insubordination</td>
<td>Reprimands</td>
<td>Disagreement re: salary/compensation</td>
</tr>
<tr>
<td>violation of company rules</td>
<td></td>
<td></td>
</tr>
<tr>
<td>poor performance</td>
<td></td>
<td>Bonuses lower than expected or removed</td>
</tr>
<tr>
<td>not being a team player</td>
<td></td>
<td></td>
</tr>
<tr>
<td>false information on background check</td>
<td></td>
<td>Failure to offer severance package</td>
</tr>
<tr>
<td>discussion about termination of employment</td>
<td></td>
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</tbody>
</table>

**Sanctions**
- Reprimands
  - work related issues
  - aggressive and malicious behavior
- Suspension for excessive absenteeism
- Demotion due to poor performance
- Responsibilities removed from projects
- Suspension of Internet access

**Death in family; Divorce**

**Financial**
- Passed over for promotion
- Disagreements
  - with supervisor
  - with colleagues
- Transfer between departments
- New supervisor hired
- Access changed
- Termination of subcontractor contract
- Termination of partnership
- Termination of other employees
- Outsourcing of project
- Demotion due to project completion
Observation #4:

Behavioral precursors were often observable in insider IT sabotage cases but ignored by the organization.
Case Example – Observation #4

A “weird tech guy” is able to attack following termination because no one recognizes the danger signs.
Behavioral Precursors

- 20% No concerning behavior
- 80% Concerning behavior
Behavioral Precursors Observed in Cases

- Drug use
- Conflicts (coworkers, supervisor)
- Aggressive or violent behavior
- Web surfing, chat rooms at work
- Mood swings
- Bizarre behavior
- Used organization’s computers for personal business
- Poor performance
- EEO complaint
- Absence/tardiness
- Sexual harassment
- Poor hygiene
Behavioral Rule Violations Ignored in Cases

- Inappropriate purchases on company accounts
- Lack of background / reference / employment references
- Lied about professional certifications
- Poor work habits
- Irregular hours
- Drinking / smoking on the job
- Sexist comments to co-workers
- Excessive unproductive time
- Worked from home against company policy
- Propositioned co-workers with numerous computer ventures - using organization resources
- Violated dress code
Observation #5:

*Insiders created or used access paths unknown to management to set up their attack and conceal their identity or actions.*

*The majority attacked after termination.*
Case Example – Observation #5

The “weird tech guy” realizes the end is near so he sneakily sets up his attack.
Created or used unknown access paths

- No unknown access paths: 25%
- Unknown access paths: 75%
Unknown Access Paths Observed in Cases

- Planted logic bomb while still employed
- Created backdoors before termination or after being notified of termination
- Installed modem for access following termination
- Changed all passwords right before resignation
- Disabled anti-virus on desktop & tested virus
- Network probing
- Installed remote network administration tool
- Download and installation of malicious code and tools (e.g., password cracker or virus)
- Disabling of system logs & removal of history files
Observation #6:

*In many cases, organizations failed to detect technical precursors.*
Case Example – Observation #6

A logic bomb sits undetected for 6 months before finally wreaking havoc on a telecommunications firm.
Technical precursors undetected

- No Undetected technical precursors (13%)
- Undetected technical precursors (87%)
Undetected Technical Precursors Observed in Cases

- Downloading and use of “hacker tools” such as rootkits, password sniffers, or password crackers
- Failure to create backups as required
- Failure to document systems or software as required
- Unauthorized access of customers’ systems
- Unauthorized use of coworkers machines left logged in
- Sharing passwords with others & demanded passwords from subordinates
- System access following termination
- Refusal to swipe badge to record physical access
- Access of web sites prohibited by acceptable use policy
- Refusal to return laptop upon termination
- Use of backdoor accounts
- Use of organization’s system for game playing, violating acceptable use policy
- Set up every new computer so he could access it remotely
Observation #7:

Lack of physical and electronic access controls facilitated IT sabotage.
Case Example – Observation #7

Emergency services are forced to rely on manual address lookups for 911 calls when an insider sabotages the system.
Lack of Access Controls

- Adequate Access Controls: 7%
- Inadequate Access Controls: 93%
Access Control Vulnerabilities Observed in Cases

Access following termination
Did not remove system administrator privileges
Only physical access controls – no electronic
Insider permitted to have sole copy of source code
Physical & electronic access permitted the rest of the day after termination
Ability to release changes to customer systems with no two man rule
Insider permitted to retain computer account following termination (with reduced privileges)
Insider able to release logic bomb to production system – no 2 man rule
Use of coworker’s computer left logged in unattended
Insider never swiped badge
Insiders created backdoor accounts that were not detected
MERIT Model Overview
System Dynamics Approach

A method and supporting toolset

- To holistically model, document, and analyze
- Complex problems as they evolve over time
- And develop effective mitigation strategies
- That balance competing concerns

System Dynamics supports simulation to

- Validate characterization of problem
- Test out alternate mitigation strategies
Model Exposition

Our system dynamics model is described as a sequence of feedback loops that tells how the problem (i.e., insider sabotage) unfolds

- Each feedback loop describes a single aspect of the problem
- Multiple feedback loops interact to describe the complex nature of the problem
MERIT Model – Extreme Overview

actual risk of insider attack

technical precursor

technical precursor

unknown access paths

acquiring unknown paths

forgetting paths

discovering paths

disabling paths

tracking

personal predisposition

precipitating event

insider's expectation

expectation fulfillment

insider demotion or termination

org's trust of insider

unknown access paths

positive intervention

sanctions

disgruntlement

behavioral precursor

discovery of precursors

behavioral monitoring

technical monitoring

perceived risk of insider attack

ability to conceal activity

discovering paths

disabling paths

insider's unmet expectation

insider's expectation
Best Practices
<table>
<thead>
<tr>
<th>Institute periodic enterprise-wide risk assessments.</th>
<th>Actively defend against malicious code.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institute periodic security awareness training for all employees.</td>
<td>Use layered defense against remote attacks.</td>
</tr>
<tr>
<td>Enforce separation of duties and least privilege.</td>
<td>Monitor and respond to suspicious or disruptive behavior.</td>
</tr>
<tr>
<td>Implement strict password and account management policies and practices.</td>
<td>Deactivate computer access following termination.</td>
</tr>
<tr>
<td>Log, monitor, and audit employee online actions.</td>
<td>Collect and save data for use in investigations.</td>
</tr>
<tr>
<td>Use extra caution with system administrators and privileged users.</td>
<td>Implement secure backup and recovery processes.</td>
</tr>
<tr>
<td></td>
<td>Clearly document insider threat controls.</td>
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</tbody>
</table>
Future Work
New Starts & Future Work

New Starts

- Requirements for insider threat detection tools
- CyLab MERIT-IA (MERIT InterActive)
  - Analysis of current cases

Future Work

- Self-directed risk assessment
- Best practice collaboration
- Investigative guidelines
- Extension/analysis of MERIT model
- Insider threat workshops
Questions / Comments
CERT Insider Threat Reports

CERT Insider Threat Website: http://www.cert.org/insider_threat/


Other related Insider reports


Points of Contact

Dawn M. Cappelli
Senior Member of the Technical Staff
CERT Programs
Software Engineering Institute
Carnegie Mellon University
4500 Fifth Avenue
Pittsburgh, PA 15213-3890
+1 412 268-9136 – Phone
dmc@cert.org – Email

Andrew P. Moore
Senior Member of the Technical Staff
CERT Programs
Software Engineering Institute
Carnegie Mellon University
4500 Fifth Avenue
Pittsburgh, PA 15213-3890
+1 412 268-5465 – Phone
apm@cert.org – Email

Eric D. Shaw, Ph.D.
Consulting & Clinical Psychology, Ltd.
5225 Connecticut Ave. NW
Washington, DC 20015
202-686-9150
eshaw@msn.com

CERT Insider Threat Web Site:
http://www.cert.org/insider_threat/