

OPERATIONAL IT FAILURES, IT VALUE DESTRUCTION, AND BOARD-LEVEL IT GOVERNANCE CHANGES¹

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Appendix A

Operational IT Failures Classification

Following Goldstein et al. (2011), we classify operational IT failures into *data-* and *function-*related IT failures. *Data-*related IT failures are those that result in disclosure of confidential data assets to unauthorized parties, misuse of data assets, or destruction of data assets. *Function-*related IT failures are those that result in loss of availability, or are the result of the mis-operation, of functional IT assets responsible for the handling of data assets.

Consistent with Benaroch et al. (2012), we define *operational IT failure* as any threat to the integrity, confidentiality, or availability of data assets or IT assets (software, hardware, networks, users, system operators, etc.) responsible for the creation, storage, processing, transport, and safeguarding of data assets.

Confidentiality events are violations of the assurance that data and IT assets are shared only among authorized persons, systems, or organizations. These events include intentional incidents, such as phishing and hacker attacks on sensitive data (e.g., trade secrets, customer data), misuse of access codes, emailing of confidential data by unauthorized internal personnel, theft of proprietary source code; and unintentional data leakage incidents, such as loss of notebooks with sensitive data by an employee, erroneous posting of customer data on the firm's website, and vendor loss of data in transport.

Integrity events are violations of the assurance that data and IT assets, including information flows, are authentic (i.e., genuine and trustworthy) and correct (i.e., preserved without corruption). Examples of Integrity events include erroneous updates of customer accounts by buggy software, user mistyping of a social security number, execution of unauthorized trades by external hackers, transactions settled at incorrect prices because of an erroneous data feed, ATM network malfunction due to a software bug, executing an incorrect trade due to a trader's keystroke error, accidental or malicious deletion or modification of important data or programs by computer viruses or worms, and defacing of a company's website by hackers.

Availability events are violations of the assurance that data and IT assets are delivered on a timely basis to those who need them. Examples include denial-of-service attacks and viruses that reproduce to overwhelm network bandwidth and email servers); unforeseen or accidental causes such as technical problems (e.g., hardware malfunctions, network outages, power failures, system crashes, and ISP problems that prevent a website from receiving customer e-orders); and, natural phenomena (e.g., floods and earthquakes), and human errors (e.g., operator errors).

References

- Goldstein, J., Chernobai, A., and Benaroch, M. 2011. "Event Study Analysis of the Economic Impact of IT Operational Risk and its Subcategories," *Journal of the Association of Information Systems* (12:9), pp. 606-631.
- Benaroch, M., Chernobai, A., and Goldstein, J. 2012. "An Internal Control Perspective on the Market Value Consequences of IT Operational Risk Events," *International Journal of Accounting Information Systems* (13:4), pp. 357-381.

Appendix B

Examples of Operational Failures

Table B1 provides a brief summary of selected operational IT failures in our sample.

Announcement Date	Company Name	Event's Brief Description
12/22/2000	SunTrust Banks	Computer software glitches resulted in customer inability to use debit cards
6/3/2002	Knight Trading Group	Software glitch led to massive sell orders in company's own stock
8/25/2003	Morgan Stanley Dean Witter	Ex-employee sold mobile device without purging confidential data
9/14/2004	Wachovia	Merger-related system failures resulted in loss of access to customer information
5/3/2005	SunTrust Banks	Employee sold bank's proprietary information, used to make counterfeit checks
6/22/2006	Ameritrade Holding	Technical glitch prevented customers from logging onto online brokerage accounts
4/5/2007	Citigroup	Trading accounts opened through information gained through identity theft
5/14/2008	SLM Corp (Sallie Mae)	Coding error resulted in loans erroneously reported as delinquent

Appendix C

Sample IT Governance Data

We illustrate three examples of our IT governance data coding procedure using data from proxy statements, DEF 14A, that publicly traded firms file with the SEC. These proxy statements are available through the EDGAR database. (The URL links provided lead to these source data.)

Example 1.

Firm Name: E*Trade Financial Corporation

Operational IT Failure Announcement Dates: 2/9/2000, 9/21/2000, 11/2/2005, 10/23/2006, 5/27/2008.

CIO Data:

- Example of media coverage around CIO appointment: *InformationWeek*, 11/18/2005. http://www.wallstreetandtech.com/framke-promoted-to-e*trade-cio/d/d-id/1257393?
Greg Framke, formerly executive vice president of E*Trade Financial Corp., has been promoted to E*Trade's CIO. The appointment comes following the retirement of CTO Joshua Levine, who plans to remain with E*Trade as a strategic consultant. In his new role, Framke will head the management and strategy of global technology at E*Trade.

“I think that it's something that the company takes pretty seriously ... developing people who can then assume a position of leadership when we have people leave,” Framke says of his promotion. “I think that's less disruptive to the organization.”

Before joining E*Trade in 2000, Framke was director and COO for global equities technology at Deutsche Bank in London. He also has held positions at Morgan Stanley and IBM.

Among his primary goals as CIO, Framke says, are “to continue to be a technology innovator and a customer champion. ... We want to continue to make customers feel very secure doing business with E*Trade.”

- DEF 14A filing, 4/24/2009: <http://www.sec.gov/Archives/edgar/data/1015780/000119312509087098/ddef14a.htm>.
Greg Framke is the Executive Vice President, Chief Information and Operations Officer, a position he has held since 2005. Mr. Framke oversees the management of all global technology development and infrastructure, as well as our core global operations. Mr. Framke has been recognized as one of InfoWorld's 25 Most Influential CTOs and as a ComputerWorld Honors Program Laureate. Prior to joining the Company, Mr. Framke was Director and Global Equity Technology Chief Operating Officer for Deutsche Bank Securities. Mr. Framke holds a BA in International Finance, graduating with honors from The George Washington University.

Risk Committee Data:

- DEF 14A filing, 4/21/2006: http://www.sec.gov/Archives/edgar/data/1015780/000120677406000853/e-trade_nps1.htm.
Audit Committee's report. Disclosure and Other Risk Management and Compliance Matters. [...] The Committee shall review the Company's policies and practices with respect to risk assessment and risk management, including discussing with management and the internal auditors the Company's major financial risk exposures and the steps that have been taken to monitor and control such exposures.

Directors' and Executives' IT Expertise Data:

- George A. Hayter, Chairman of the Board since 2003.
DEF 14A filing, 4/21/2006: http://www.sec.gov/Archives/edgar/data/1015780/000120677406000853/e-trade_nps1.htm.
George A. Hayter has been a director of the Company since December 1995 and Chairman of the Board since 2003. Mr. Hayter has been a partner of George Hayter Associates, a consulting firm, since 1990, providing guidance to emerging stock exchanges. From 1976 to 1990, he served with the London Stock Exchange, with responsibility for information and trading systems. Mr. Hayter serves as a director of Surfcontrol, PLC, a London Stock Exchange listed specialist software provider. He received a master of arts in natural sciences from Queens' College, Cambridge, England. In addition to his role as Chairman of the Board, Mr. Hayter is a member of the Nominating and Corporate Governance Committee.
- Robert A. Druskin, Chairman of the Board since 2008.
DEF 14A filing, 4/12/2010: <http://www.sec.gov/Archives/edgar/data/1015780/000119312510081061/ddef14a.htm>
Robert A. Druskin has been a director of the Company since February 2008 and served as Lead Director from May 2009 through December 2009. Mr. Druskin became Chairman of the Board in December, 2009 and served as Interim Chief Executive Officer of the Company from December 31, 2009 until March 31, 2010. He also became Chairman of the Board of E*TRADE Bank and Chairman and a member of the Boards of E*TRADE Savings Bank, E*TRADE United Bank and ETB Holdings, Inc, each subsidiaries of the Company, on December 31, 2009. Mr. Druskin is former Chief Operating Officer of Citigroup and was a member of the Office of the Chairman. He joined Smith Barney (now a division of Citigroup) in 1991 as Chief Administrative Officer, later taking on the role of head of Asset Management and the Futures Division before returning to the role of Chief Administrative Officer. In 2000, Mr. Druskin became Chief Operations and Technology Officer for Citi. He later became the President and Chief Operating Officer, then Chief Executive Officer, of Citi Markets & Banking. He served as Chief Operating Officer of Citigroup from December 2006 until December 2007, when he retired from the company. Mr. Druskin has been a member of the Board of Directors of Affiliated Computer Services, a publicly traded company, since 2008. Mr. Druskin earned a Bachelor of Arts from Rutgers University.
- C. Cathleen Raffaelli, independent director since 2003.
DEF 14A filing, 4/12/2010: <http://www.sec.gov/Archives/edgar/data/1015780/000119312510081061/ddef14a.htm>
C. Cathleen Raffaelli has been a director of the Company since April 2003. Ms. Raffaelli is the president and managing director of The Hamilton White Group, LLC, an investment and advisory group providing support for strategic partnering, business development, sales and marketing strategy to companies in financial services growth markets and education sectors. From 2004 through 2006, Ms. Raffaelli was the Chief Executive Officer and President of Cardean Learning Group (formerly Unext, Inc.), a privately held company that develops and delivers online education using advances in cognitive science and technology. Prior to 2004, she was a managing partner of The Hamilton White Group, LLC, the position to which she returned in 2006. Ms. Raffaelli serves as a director of the New York Federal Home Loan Bank, Indecomm Global Services, Brookline College, Potomac College and the University of Business and International Studies in Geneva, Switzerland. Ms. Raffaelli received a Bachelor of Science degree from the University of Baltimore and a Master of Business Administration from New York University. Ms. Raffaelli is a member of the Compensation and the Finance and Risk Oversight Committees.

- Donna L. Weaver, independent director since 2003.
DEF 14A filing, 4/12/2010: <http://www.sec.gov/Archives/edgar/data/1015780/000119312510081061/ddef14a.htm>
Donna L. Weaver has been a director of the Company since April 2003. Ms. Weaver is Chairman of MxSecure, Inc., a provider of internet-based transcription, electronic health record and speech recognition services and software to medical practices nationwide. A Certified Management Accountant, Ms. Weaver received a Bachelor of Science from the University of Arizona in Economics and Finance and a Master of Science in Management from the Stanford Graduate School of Business. Ms. Weaver has served on the boards of several public and private companies during her career. Ms. Weaver is Chair of the Nominating and Corporate Governance Committee and a member of the Audit Committee.

Example 2.

Firm name: Wachovia Corporation

Operational IT Failure Announcement Dates: 6/5/1992, 9/7/2004.

CIO Data:

- Bloomberg, <http://www.bloomberg.com/research/stocks/people/person.asp?personId=193225&ticker=PSTB&previousCapId=30901409&previousTitle=PARK%2520STERLING%2520CORP>.
Ms. Jean E. Davis served as a Senior Executive Vice President of Wachovia Corp., since September 2001. Ms. Davis served as Head of Information Technology, eCommerce and Operations of Wachovia Corp., from 1999 to March 7, 2006. Previously, she served as Executive Vice President, Wachovia Operational Services from February 1999 to September 2001; Human Resources Director, from February 1998 to February 1999, and prior to February 1998, Regional Executive-Piedmont Triad Region, Legacy Wachovia. She served as Senior Executive Vice President at Wachovia Securities, Inc.
- Example of media coverage around CIO appointment: www.bizjournals.com, 3/7/2006.
<http://www.bizjournals.com/charlotte/stories/2006/03/06/daily15.html>
Wachovia Corp. has promoted Gerald Enos Jr. to head of operations, technology and e-commerce, effective immediately. He succeeds Jean Davis, who is retiring after a 21-year career at the Charlotte-based bank.
Enos will be responsible for the management and oversight of Wachovia's online channels, technology infrastructure, applications and operational services.
Enos has been with Wachovia for nearly 25 years in a range of business and infrastructure roles. Most recently, he was head of operations.

Board-Level IT Committee Data:

DEF 14A filing, 3/14/2005: <http://www.sec.gov/Archives/edgar/data/36995/000119312505049249/ddef14a.htm>.

[T]he board maintained a Merger Integration & Technology Committee for part of 2004. The Merger Integration & Technology Committee held 2 meetings in 2004.

Directors' and Executives' IT Expertise Data:

David M. Carroll, executive director since 2004.

Bloomberg: <http://www.bloomberg.com/research/stocks/people/person.asp?personId=7794417&ticker=WFC>

[Mr. David M. Carroll] served as the President of Capital Management Group of Wachovia Corp., since October 1, 2004. Mr. Carroll served as the Head of Corporate Support Services and Merger Integration at Wachovia Corp., which includes marketing, Chief E-Commerce and Technology Officer, General Banking Group Executive of First Union-Virginia, Executive Vice President of First Union-South Carolina, Senior Vice President and Region Executive in Eastern South Carolina, Commercial Banking Manager and Area Executive of Greenville/Anderson, SC, Commercial Banking Officer in Burlington, N.C, National Accounts Officer in the multinational division of the Corporate Banking Group, Manager, Financial Services office in Atlanta and Credit Analyst. He also oversees the pending \$14 billion acquisition of SouthTrust Corp. and is on Wachovia's 17-Member operating committee. He has served at Wachovia Corp., for 23 years and was widely praised for a smooth integration after First Union Corp. He served as a Senior Executive Vice President of Wachovia Corporation from September 2001 to January 2009. Mr. Carroll served as an Executive Vice President and Chief E-Commerce Officer of Wachovia Corp. (Former Name: First Union Corp.) from May 1999 to September 2001, and served as the President and Chief Executive Officer of First Union-Florida from January 1998 to May 1999, and President and Chief Executive Officer of First Union-Georgia until December 1997. Mr. Carroll serves as a Vice Chairman of First Union-Virginia. He holds BS in Business Administration from University of North Carolina-Chapel Hill.

Example 3.

Firm Name: American Express Company

Operational IT Failure Announcement Date: 5/14/2008.

CIO Data:

- DEF 14A filing: <http://www.sec.gov/Archives/edgar/data/4962/000119312509055047/ddef14a.htm>
[Stephen] J. Squeri, Executive Vice President, Corporate Development and Chief Information Officer.

- Bloomberg, <http://www.bloomberg.com/research/stocks/people/person.asp?personId=22451187&privcapId=92001>. Mr. Stephen J. Squeri ... served as [American Express Company's] Chief Information Officer and Executive Vice President from May 2005 to October 2009. ... From 2000 to 2002, Mr. Squeri served as the President of Establishment Services Canada and the United States where he oversaw American Express' efforts to grow merchants' businesses through innovative marketing and e-commerce programs and managed merchant acquisition efforts.
- Example of media coverage around CIO appointment: *Business Wire*, 5/2/2005: <http://www.businesswire.com/news/home/20050502006143/en/American-Express-Appoints-Stephen-Squeri-Executive-Vice>
American Express Company today announced the appointment of Stephen Squeri, 46, to the position of executive vice president, chief information officer, effective immediately. ... As head of the global Technologies organization, Mr. Squeri will be responsible for further strengthening the company's position as an industry leader in the strategic use of technology, and will continue to serve on the company's Global Management Team. ... "For the critically important position of CIO, we looked for someone who has demonstrated the ability to integrate leading edge technologies into successful business building initiatives, and who possesses a combination of outstanding business acumen, a keen focus on the customer and strong organizational leadership skills," said Ken Chenault, chairman and CEO. "Steve has strengths in all of these areas, as well as a deep and broad knowledge of our core businesses." ... Mr. Squeri has been responsible for a long list of accomplishments over the course of his 20-year career at American Express, including many instances of effectively using technology to build business.

Risk Committee Data:

DEF 14A filing, 3/22/2011:

<http://www.sec.gov/cgi-bin/browse-edgar?action=getcompany&CIK=00004962&type=DEF+14A&dateb=&owner=exclude&count=40>
Audit and Risk Committee. The Audit and Risk Committee meets regularly in executive session with the Company's Chief Risk Officer with regard to the Company's risk management processes, controls, and capabilities.

Board-Level IT Committee Data:

DEF 14A filing, 3/22/2011:

<http://www.sec.gov/cgi-bin/browse-edgar?action=getcompany&CIK=00004962&type=DEF+14A&dateb=&owner=exclude&count=40>
The Innovation and Technology Committee was established by the Board of Directors in July 2010 to assist the Board in its oversight of strategic innovation and technology. In carrying out its responsibilities, this Committee is responsible for reviewing and making recommendations to the Board on major strategies and plans developed by management relating to the Company's approach to technological and commercial innovation, the innovation and technology acquisition process to assure ongoing business growth, and measurement and tracking systems in place to achieve successful innovation.

Directors' and Executives' IT Expertise Data:

- Peter Chernin, independent director since 2006.
DEF 14A filing, 3/22/2011:
<http://www.sec.gov/cgi-bin/browse-edgar?action=getcompany&CIK=00004962&type=DEF+14A&dateb=&owner=exclude&count=40>
Founder and Chairman, Chernin Entertainment, Inc., a film and television production company, and The Chernin Group, which is involved in strategic opportunities in media, technology, and entertainment, June 2009 to present. Mr. Chernin was President, Chief Operating Officer, and a director of News Corporation from October 1996 to June 2009, and was Chairman and Chief Executive Officer of the Fox Group, where he oversaw the global operations of the company's film, television, satellite cable, and digital media businesses. At News Corporation, Mr. Chernin led the company's expansion into the broadband and mobile markets, through the creation of Fox Interactive Media, Hulu, Jamba, and other digital properties. ... Mr. Chernin is a former director of News Corporation, DirecTV, Inc., and Gemstar/T.V. Guide International. Specific qualifications, experience, skills, and expertise: Operating and senior management experience at a leading global media corporation; Core business, management, and leadership skills; Expertise in online and digital markets, media, social networking, and other new technologies; Public company director and committee experience. ... Mr. Chernin brings to the Board his extensive senior leadership, financial, and management experience, and his expertise in building industry leading businesses, developing innovative and forward-thinking approaches, and expanding traditional businesses in online and digital markets, as well as his core business skills and public company director experience.
- Richard A. McGinn, independent director since 1998.
DEF 14A filing, 3/22/2011:
<http://www.sec.gov/cgi-bin/browse-edgar?action=getcompany&CIK=00004962&type=DEF+14A&dateb=&owner=exclude&count=40>
General Partner, MR Investment Partners, a private equity firm that invests in technologies businesses, since April 2010. Mr. McGinn was formerly a General Partner of RRE Ventures, a private firm that invests in early stage technologies businesses, from August 2001 to April 2010. ... Specific qualifications, experience, skills, and expertise: Operating and management experience, including as chief

executive officer, in global communication systems, networking, and technology businesses; Core business, management, and leadership skills, and financial and investment expertise; Expertise in global business opportunities in telecommunications, mobile, online, and new technologies; Public company director and committee experience. Mr. McGinn brings to the Board his deep business, investment, and financial experience, his expertise in analyzing business developments and opportunities in telecommunications, mobile, online, and new technologies, as well as his core business and leadership skills and public company director experience.

- Edward D. Miller, independent director since 2003.
DEF 14A filing, 3/22/2011:
<http://www.sec.gov/cgi-bin/browse-edgar?action=getcompany&CIK=00004962&type=DEF+14A&dateb=&owner=exclude&count=40>
Former President and Chief Executive Officer, AXA Financial, Inc., a U.S.-based financial services organization providing asset management, financial advisory, and insurance services, since May 2001; member, Supervisory Board and Senior Advisor to Chief Executive of AXA Group, June 2001 to April 2003; Chief Executive Officer, August 1997 to June 2001. Prior to joining AXA Financial, Mr. Miller served as the President of Chemical Bank and held senior positions at Manufacturers Hanover Trust and The Chase Manhattan Bank. Mr. Miller is a director of Korn/Ferry International and The Feinstein Institute for Medical Research. He serves as Chairman of the Partnership for New York City's Security and Risk Management Task Force and as a trustee of the New York City Police Foundation and of Phoenix House. Mr. Miller is a former director of KeySpan Corp. and Topps Company. Specific qualifications, experience, skills, and expertise: Operating and senior management experience, including as chief executive officer, at highly regulated, global financial services businesses; Core business, management, and leadership skills; Banking and financial services expertise, and expertise in card and payment networks; Public company director and committee experience. Mr. Miller brings to the Board his extensive experience in the U.S. banking and payments industry and in global financial services businesses, his experiences leading highly regulated global entities, and his extensive leadership, operating, management, and core business skills, as well as his public company director experience.
- Ronald A. Williams, independent director since 2007.
DEF 14A filing, 3/22/2011:
<http://www.sec.gov/cgi-bin/browse-edgar?action=getcompany&CIK=00004962&type=DEF+14A&dateb=&owner=exclude&count=40>
Chairman, Aetna Inc., a leading diversified health care benefits company, since November 2010; Chairman and Chief Executive Officer, October 2006 to November 2010; President and Chief Executive Officer, February 2006 to October 2006; and President, May 2002 to February 2006. Mr. Williams is a director of The Boeing Company. He is a member of The Business Council and a member of the Dean's Advisory Council and Alfred P. Sloan Management Society at the Massachusetts Institute of Technology. He is a former director of Lucent Technologies. Prior to joining Aetna, Mr. Williams co-founded several businesses and served in senior management positions at a number of other companies. Specific qualifications, experience, skills, and expertise: Operating and senior management experience, including as chief executive officer, in a highly regulated industry; Core business, management, and leadership skills and financial expertise; Expertise in creating innovation through information technology; Public company director and committee experience. Mr. Williams brings to the Board his extensive management, operations, and business experience leading in a rapidly changing and highly regulated industry, his focus on innovation through information technology, his leadership, financial and core business skills, and his public company director experience.
- Richard C. Levin, independent director since 2007.
DEF 14A filing, 3/22/2011:
<http://www.sec.gov/cgi-bin/browse-edgar?action=getcompany&CIK=00004962&type=DEF+14A&dateb=&owner=exclude&count=40>
President, Yale University, a private, independent university, since July 1993, and Frederick William Beinecke Professor of Economics. Former Chair of Yale's Economics Department and Dean of Yale's Graduate School of Arts and Science. Mr. Levin is a trustee of the William and Flora Hewlett Foundation, one of the largest philanthropic organizations in the United States. He is a member of the National Committee on United States-China Relations and a Fellow of the American Academy of Arts and Sciences. Mr. Levin is a trustee and vice chair of The Climate Works Foundation. He is a director of C-3, an energy resource management company, and a former director of Satmetrix Systems, Inc. and Lucent Technologies. Mr. Levin has served on a number of Presidential Commissions and was appointed by President Barack Obama to serve on the President's Council of Advisors for Science and Technology. Specific qualifications, experience, skills, and expertise: Recognized as a leader of American higher education; Distinguished economist, with expertise in economic theory, statistical analysis, modeling, and analyzing economic trends; Leader in U.S.-China cooperation through his development of extensive relationships between Yale University and China; Public company director and committee experience. Mr. Levin brings to the Board his experience and vision in leading Yale University, one of the world's most prestigious institutions of higher education, his involvement in a wide range of international initiatives at Yale University, his expertise in economics, statistics, and analysis, and his public company director and public policy experience.