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Tip of the Iceberg Simplicity in E-Commerce: Issues for Educators

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ABSTRACT

Educators must address issues of hidden complexity in E-commerce, to prepare students for the realities of designing and managing full scale web sites. This paper addresses the problem from the theoretical perspective of Charles Perrow's Normal Accident Theory, as extended by Lally. Three key areas of E-commerce are examined where the complexity, tight coupling, control and change, suggested by the extended theory, can impact E-commerce success: 1) the World Wide Webs infrastructure, 2) the growing size and sophistication of Web sites, and 3) the increasing interactivity and personalization of Interface design.

INTRODUCTION

As E-commerce matures as a discipline, educators must address why so many Dot.Com businesses have been failures. They need to provide students with an enhanced theoretical foundation, as well as practical suggestions, for building successful E-commerce applications. This paper will argue: 1) the ease of Internet use masked the complexity of the Internet's underlying infrastructure, and 2) the ease of designing simple sites masked the complexity of full E-commerce sites. During the 1990s, this "Tip of the Iceberg Simplicity" lured many entrepreneurs and investors into many short lived Dot.Com ventures.

NORMAL ACCIDENT THEORY AND INFORMATION TECHNOLOGY

This paper will draw on Lally's (2002) extension of Perrow's Normal Accident Theory (1984, 1999). Perrow developed his theory studying complex systems such as nuclear power plants. He distinguished characteristics of systems that would permit single failures, called "incidents" such as an operator error, to propagate into major accidents such as meltdowns. Systems that had these characteristics were likely to be subject to accidents in the normal course of their operation. Perrow concluded that accident prone systems are more:

1) **Complex**--with multiple versus linear interactions, and invisible interactions with only the "Tip of the Iceberg" visible, leading to the problem of "**unknowability,"**
2) **Tightly couples**--with no slack time to allow incidents to be intercepted,
3) **Poorly controlled--**with less opportunity for human intervention before problems spread.

Lally argued that Normal Accident Theory is a sound theoretical perspective for understanding the risks of Information Technology, because IT is:

1) **Complex**--The hardware that makes up IT infrastructures of most organizations is complex, containing a wide range of technologies. Software often contains thousands of lines of code written by dozens of programmers. Incidents such as bugs can, therefor, propogate in unexpected ways.

2) **Tightly coupled**--Both hardware and software are designed to increase the speed and efficiency of operations. Incidents such as operator errors can quickly have real world impacts.

3) **Changes in software**--Security features are often not built into systems. Testing of software is often inadequate in the rush to meet release deadlines.

Lally applied this theory to various aspects of Information Technology including reengineering (Lally, 1996, 1997), the Y2K problem (Lally 1999), hiring (Lally, 2000), (Lally and Garbushian, 2001). Lally concluded (Lally 2002) that the rapid pace of **change** in Information Technology is further exacerbating factor increasing the likelihood of disasters.

1) **Changes in Hardware**--According to Moore's Law, hardware doubles in power every 18 months. As a result, hardware continues to evolve rapidly. Furthermore, entirely new kinds of hardware appear and must be integrated into existing systems.

2) **Changes in Software**--New software released fuel revenue streams in the software industry, resulting in mandatory "upgrades" every two years. The changes create an additional learning burden on users. Programmers are again under time pressure that can result in poor testing and de-bugging (Halfgill, 1998), (Westland, 2000), (Austin, 2001).

In addition to these first order effect, changes in IT also create second order effects by enabling changes in organizational processes. These processes can also become more complex, tightly coupled, and poorly controlled, further increasing the problem of serious accidents. As a result, IT users are faced with complex, tightly coupled, poorly controlled systems that undergo radical changes on a regular basis, making these systems more prone to "Normal Accidents".

This paper will apply Lally's extension of Perrow's theory to E-commerce, specifically to the issues of complexity, coupling, control and change in E-commerce infrastructures and interfaces. Recommendations for E-commerce educators for providing a more complete theoretical and practical foundation for the field will conclude the paper.

THE SIREN CALL OF FALSE SIMPLICITY

Although electronic commerce has existed for over twenty years in the form of EDI, before the Internet and its World Wide Web interface appeared, the costs associated with EDI implementations excluded all but large organizations such as Proctor and Gamble and Wall-Mart from enjoying its benefits (Schneider and Perry, 2000).

The infrastructure of the Internet and brought the benefits of EDI within the reach of small to medium sized businesses. The Internet was public and had much lower start up costs. It had an open architecture, not proprietary standards, making connections easier. As a result many smaller organizations began using the Web to exchange information with suppliers and customers. New organizational structures, including "pure play" businesses like Amazon.com and Ebay appeared without any physical retail outlet, beyond their Web site and underlying infrastructure. Small businesses targeting limited market niches (ostrich feathers, hand carved chess sets) were able to use the Internet to create a global retail presence.

The user friendly interface of the World Wide Web also fueled the enthusiasm. The Web was simple to use and the basic features of HTML generators like Frontpage and Dreamweaver straightforward to master. Simple sites involving text, links, graphics, and an email generator could be designed in a few hours. Hosting costs for simple sites, such as the text based sites used by news columnists, were only a few thousand dollars a year.

This tip of the iceberg simplicity attracted thousands of small and medium sized businesses to the Web and thousands of potential Web designers into E-Commerce classes. However, the realities of designing, creating, and maintaining many of the Web based businesses envisioned resulted in much disillusionment.

INFRASTRUCTURE ISSUES

"The information technology and communication systems that support E-commerce are so incredibly complex that few (if any) people understand all the components in depth" (Davis & Benamati, 2002. P, 8).

The World Wide Web is built on a telecommunications infrastructure that is **highly complex**. Transmission media can include local phone lines, satellites, DSL lines, cable connections, leased lines, and fiber optic cables. The topology of systems connecting to the Web can range from stand alone PCs, to LANs and WANs. The TCP/IP protocol on which the Web runs is a complex four layer packet switching protocol. Although the Web allows for local failures to be circumvented, identifying, isolating and fixing a failure is a time consuming task requiring high levels of expertise. Web site designers need to be aware of the underlying infrastructure issues that can affect a site's performance.

Information posted on the World Wide Web is disseminated globally within seconds making the Web **tightly coupled**. This tight coupling allows for the inexpensive dissemination of important information such as breaking news. However, false information and rumors can spread just as quickly having real world implications. When Dell Computer's mainframe failed to send the proper data to its web page server, monitors were listed as selling for $0. Over a hundred orders came in before the problem was realized and fixed (Gates, 1999). In the post 9/11 environment, research and government sites also became aware that the information on their sites might be used by potential terrorists and removed information. Web designers need to be made aware of the importance of the accuracy of their site's information content, and also realize that information posted on a publicly accessible site can be accessed by malicious individuals as well as its intended audience.

Individuals can create Web sites and businesses easily that span international jurisdictions, making the Web **difficult to control**. Laws regarding what constitutes a legitimate business vary from one nation to the next. Web sites can provide products such as drugs without prescriptions, or services such as gambling that circumvent local legislation. Nations also differ regarding intellectual property rights and Web oriented legislation is still catching up with the ability of Web technology to disseminate copyrighted information with ease. Wrongdoers can be hard to isolate and prosecute. Web designers need to be aware of potential legal issues regarding the products and services offered by their site.

The Web's open architecture allow for new users and sites to be added, removed, and replaced continually, making the Web subject to continual **change**. The topology of the Web changes on a daily basis as does the range of technologies that make of the Web's infrastructure. Web based businesses can appear and disappear overnight. Finally, the TCP/IP protocol of the Net makes the Web a "stateless system"--it does not remember the transactions that occurred in the past, raising the problem of **unknowability**. Web designers need to be aware of emerging Web technologies, such as mobile devices with limited bandwidth, and how these technologies will impact the design of their sites.

HACKERS AND HIDDEN COMPLEXITY

Everyday users of the World Wide Web may be able to treat the Web as a black box, but for designers of Web based businesses, it is a recipe for disaster. Malicious users such as hackers can exploit their understanding of the Web's complexity to their own advantage.

Instances of hacker attacks that steal sensitive information such as customer credit card numbers are common. Denial of service attacks on "Pure Play" sites such as E-Trade and Amazon have resulted in millions of dollars of lost revenue. Infrastructure problems have shut down day-trading sites during peak hours (Lemos, 2001), (Vijayan, 2002).

THE GROWING COMPLEXITY OF WEB SITES

Web sites, themselves, have grown in complexity. Early sites were primarily two-tiered architecture, "transactional" client-server sites, providing simple navigation and email links. Many early successes, however, scaled up into three-tiered architecture "interactional" sites. These sites could include: 1) interactions with databases involving knowledge of SQL or other query languages, 2) CGI forms and Java applets that required sophisticated programming far beyond the knowledge required to use HTML generators, and 3) links to organizational mainframe based systems such as ERP systems requiring knowledge of SAP.

E-business sites also required shopping carts, and the ability to process payments. Although "off the shelf" versions of these features are available they often must be tailored for a particular business. For example, a book or CD store can allow customers to leave products in their shopping carts for two weeks, but sites selling one of a kind collectibles cannot. The ability to tailor content to users involves artificial intelligence technology that is another major challenge. Jeff Bezos has commented that it is the complex back-end software that gives Amazon.com its competitive edge (Bezos, 2001).

As sites grew in complexity, their interfaces also became more complex. As features such as high resolution graphics, sound, and video became available, Web designers began adding them to their sites. Each of these tools required more learning on the part of Web designers. Throughout the 1990's these tools evolved quickly resulting in new releases every year or two, making the task of keeping current even more daunting. Although multimedia features provided the potential for creating more entertaining and attractive sites, these features also greatly increased the site's load times, a major problem for users with low bandwidth connections. New site features such as frames often made sites more difficult to navigate and print. Excess use of features like Flash animations wasted users time and made sites difficult to navigate (Flanders, 2002). Usability theory and theories of human computer interaction exist (Nielsen, 1999) but are still not practiced by many Web designers.

CONCLUSION

This paper has presented Lally's Extension of Normal Accident Theory as a starting point for identifying potential problems in E-Commerce resulting from complexity, tight coupling, and change. Designers of E-Commerce courses should address these issues and incorporate methodologies for dealing with these problems.

REFERENCES AVAILABLE UPON REQUEST