

**I-Learning via an Internet-Centric IT-enabled Learning Infrastructure:
Enabling Innovation, Expediting Problem Solving, Encouraging Learning, Expanding our Memory
and Empowering those around us**

A concept of substituting zero-cost just-in-time information access for costly just-in-case learning.

C. Frank Starmer

For me, problem solving depends on what I know and available resources. When everything I need is within reach, I can teach myself mostly anything at only the cost of my time and effort which improves my solving problems. When information or resources I need are not within reach, then learning can be costly (look at the cost of a year in a typical university) and problem solving suffers. The Internet levels the playing field with respect to information access - and at a minimal cost. Does near zero-cost access bring anything to the learning table?

Education is all about brain training, and for me, the Internet + Google and an appropriate IT-enabled learning infrastructure can facilitate brain training in a way that reduces the destructive effects of forgetting and amplifies time available for learning and problem solving.

I do not know how to build the web services and a software infrastructure to enable Internet-centric learning without understanding something about learning and forgetting. Here, I have pulled together resources to help establish the framework for rational building of an Internet-centric learning model based on our best understanding of learning and forgetting. The main idea is that of identifying the basis of a *time shift*, similar to a *cost shift* that amplify time I have available for solving problems. In other words, can I identify web-centric resources that enable me to free the time required to *locate and memorize infrequently used facts and later to remember them* and, instead, apply this new time to thinking and problem solving. Obviously I believe that building an IT infrastructure that amplifies your ability to learn, think and solve problems and at the same time, enables you to avoid the forgetting curve is a productive endeavor.

Simply put, learning requires repetition over a short period of time. Unlearning, i.e. forgetting, usually occurs when learned or memorized information is infrequently used. In medical terms, a sort of disuse atrophy, similar to that seen with muscle development and muscle disuse. The forgetting curve measures the loss of learned or memorized facts as a function of time. Clearly, if I am able to depend on a search engine (e.g. Google) to locate facts and concepts more rapidly and more accurately than I can retrieve them from my memory, then I win by extending my biological memory with my Internet memory. I use my Internet memory to retrieve information I either never learned or have so infrequently used that I do not trust my memory to be accurate.

The educational challenge today is to demonstrate that Internet-centric learning is superior to book-centric learning and that Internet-centric problem solving helps me avoid memorizing unnecessary information (and thereby avoid feeding the biological forgetting process). For me, the demonstration of a competitive Internet-centric paradigm is simple. When information is presented to me without effort on my part, then time that would have been devoted to locating and accessing the information becomes available for learning and problem solving.

As an example of reducing remembering and web-site navigation, RSS feeds are used to generate the boxes below with no effort on my part. Automatically generated content boxes such as these become part of my information aggregation process that facilitates learning and information gathering. With RSS feeds presented on a web page such as below spares me the navigational effort required to view Reuters news or Nature. The Internet and RSS feeds are one example of an enabling technology, enabling me to gather information with little effort and providing me the option of expending my time on learning and problem solving.

For insights see our howto

The above content boxes are examples of information transport, bringing the headlines from Reuters and Nature to a content box near you, courtesy of RSS (at Nature). Information transport is at the core of just about everything we do. New information facilitates developing a precise articulation of a problem. Synthesizing a good solution is facilitated with rapid access to information. New information enables me to rapidly track the latest in my area of scientific interests or the latest in information technology. Consequently, my view of IT infrastructure emphasizes location and transport of information to my desk. In some ways, I'm the Minister of Data Transport and I better get it right. Understanding how we think, how we can partition time between thinking, learning, remembering and doing are essential if I am going to create an enabling IT infrastructure. If I fail to understand, then there is a high likelihood my IT infrastructure will be disabling.

There is a cost associated with education and learning - a sort of transaction cost. In many ways, it reflects a transport cost - the cost of moving information to the learner. The Internet, search engines, commodity computing and browsers have virtually driven the transaction cost to zero - implying that the market for traditional access to information will soon disappear. Howard Dean realized this and built a lean election organization as an Internet-centric organization. See also Ronald Coase's Nobel Lecture on Institutional Structure of Production. Dean bet (and lost) that there would be no market for the traditional political party, a result of excessive transaction costs - particularly associated with fun raising and spreading the word. Zero transaction costs are already available in the procurement of information, traditionally reserved for paying students.

Today, examples of low- or zero-cost transaction costs associated with learning abound. Not prepared lectures, but rather the stuff one uses to prepare a lecture or group discussion. You can download a wonderful power point presentation leading you though just about any area of interest. You can trivially access the National Library of Medicine and locate journal articles, their pdf realization and linked articles. Traditional tuition bought you access to *learned* material and you were willing to pay. The Internet has driven the transport cost to zero - and this will clearly impact our educational industry. (Note - Howard Dean did not succeed with his bid for the lead candidate - so obviously, this is much more complex than the presentation above. However, Dean clearly demonstrated that one could harness the power of the Internet in ways that have probably permanently altered the way political ideas are projected to the voting public).

We teach our students by what I call *just-in-case* content mastery (see also e_learning issues) so that they are exposed to many things. Most they will never need and will forget within a short time after learning. This seems wasteful of the student's time and money they pay for tuition. They will remember a few things that are frequently used because this blunts the forgetting curve. Just-in-case education is wasteful

of student time and wasteful of faculty time. It can be replaced with just-in-time information access. Google and the Internet create a new opportunity to develop education within the framework of just-in-time information access. This new kind of learning is *with* computers and the Internet as opposed to *from computers and the Internet*.

Here are some accumulated thoughts, strategies etc. for growing the IT infrastructure that I believe is essential for building an Internet-centric university that utilizes just-in-time information access. My strategy is based on two fundamental concepts:

1. evolving an IT infrastructure to supplement and complement functions of our biological brain - here specifically I am referring to using the Internet as a memory and thus a way to avoid the forgetting curve. The emphasis on re-targeting mental energy is based on discussions Gene Stead and I have had.
2. viewing the faculty, students and staff as Shifting Innovation with Toolkits innovators (i.e.IT is subordinate to the business, education, research and patient care missions of the university, in other words, it is a data transport and services *public* utility). I have described some of the underlying concepts here.

I divide my time between doing, thinking, memorizing/learning or remembering. Training my brain to think, is a much more productive exercise than training my brain to memorize. Yet how many courses in our university programs focus on improving the learner's ability to memorize instead of improving the learner's ability to think? Prior to the Internet and Google, there was no way out of the memorizing/remembering paradigm. New information was difficult to access and thus we focused on mastery of many many concepts, just in case we might need them for some future problem. When solving a problem, you either consulted a book, or a journal article or a colleague - but in all cases, access consumed considerable time, thus retarding the solution of a problem. Google and the Internet now reduce information access to the time required to form a Google query. We can now access information within seconds whereas before, access might require days, weeks or months. Accepting this comparison, it is clear that the time is right for reviewing our educational programs and exploring a shift away from training our brains to memorize and recall to training our brains to think and do.

Commodity computing, global connectivity, very fast CPUs, and search engines create the essential parts for building an *Internet memory* that can be substituted, in many cases, for our biological memory. Our approach emphasizes locating, harvesting and transporting knowledge to our desktop *just-in-time*. The key to understanding our strategy is distinguishing information transport from information use. I use information to solve problems. I am a better problem solver when information is available *just-in-time*. Google and the Internet-accessible resources are providing more information when I need it that I am able to retrieve from my own biological memory. Accepting this, then we are building a new educational paradigm by realizing that the internet is simply an extension of our memory and Google is our knowledge harvester. We are moving away from *memory-based traditional education* and toward *internet-based learning*, in a manner that restores the fun of acquiring and using new knowledge. Fun is derived by moving away from a system that rewards memorizing and recalling facts to a system that promotes doing something productive - that of solving problems. Our focus is building a partnership between our Internet-memory and our heads where the rewards rest with the fun of problem solving. In other words, our strategy is based on re-targeting brain energy that was previously spent memorizing and recalling to learning and thinking. It should be obvious to anyone that energy spent memorizing and recalling provides a lower return on investment than energy spent thinking. Said another way, we are moving away from

comprehensive memorizing, *just-in-case we need it in the future* to *just-in-time access to knowledge*. Google and the high speed Internet make this shift in educational paradigm possible.

To translate these ideas into reality, we are growing a new model of learning which we call *Internet-centric learning*. Internet-centric learning can be self-directed or it can be coordinated by experienced learners (sometimes called faculty or teachers). The senior learners typically focus and facilitate learning experiences with junior learners (sometimes called students). Sometimes, however, the junior learner brings new insights to the senior learner, a reflection that traditional students and faculty with internet access are playing on the same field of knowledge. We focus on problem-based learning as the basis for transferring ideas and insights among co-learners. The problem is used as a *knowledge filter*, identifying the essential concepts and facts that must be mastered in order to solve the problem. This limits the material that must be mastered, thus side stepping cluttering our head with infrequently used information, that over time, will be forgotten. Below are our thoughts about an enabling IT infrastructure, our thoughts about thinking, and GMS-specific observations that motivated much of our IT infrastructure.

Central to our new learning paradigm is a learning center - a place, maybe virtual, maybe real, where learning is facilitated. Learning, in my opinion, is facilitated when one is able to *harvest* information, consolidate it and present it in a meaningful way. Web portals present new opportunities for knowledge presentation, i.e. linking learners with harvested and consolidated information. Tools that facilitate data harvesting, knowledge consolidation and presentation are key infrastructure elements in our internet-centric learning center.

The National Weather Service has now made available forecast data in XML format and provided several SOAP services. Look at National Digital Forecast Database Web Service. In addition, RSS feeds give us frequently updated headlines that reflect content of a dynamic site. For example, here is the current contents of Reuters Science

Each time you refresh this display, the above box will reflect the current contents of Reuters Science. For me, RSS feeds are navigational tools that free me from going to a specific URL and looking at the content. A collective group of similar dynamic content boxes is really a *portal* through which you can see headlines from many resources. Search engines such as Google and htdig, are also navigational aids. I have described them here:

- How to display the GMS navigator hat
- Accessing and displaying RSS feeds

I emphasize *learning* because in today's workplace and home, continuous learning is essential. To facilitate learning, I have focused on developing software tools that enable faculty, students and staff to chase their curiosity and develop solutions to their own problems. To date, I have not succeeded in fully enabling faculty, students and staff - but rather use my IT lab as action tools that translates a faculty members needs into a working prototype, often during the course of a conversation. Rapid prototyping is the result of my emphasis on developing tools that are easily cobbled together to build prototype solutions. The prototypes facilitate refining the problem so that after three or four iterations, we have a solution. Eric von Hippel has articulated a similar strategy where the Customer is the Innovator, a concept developed in industry, in order to off load costly product development cycles to the customer by providing appropriate tools.

Ideas and a strategy for creating an enabling IT infrastructure

- A Long Term Strategy (not a plan): Getting our IT act together: An infrastructure that enables information transport and facilitates overcoming cultural obstacles Here, I emphasize strategy instead of plan because the pace of change in the IT world is sufficiently rapid (fundamentally new concepts and insights appearing every 18-24 months) so that any plan is out of date by the time it is finalized. A strategy highlights the main path(s) that a plan would follow and is sufficiently flexible to permit midcourse adjustments needed to adapt to new technologies. Standards and open source resources enhance our ability to respond rapidly to new ideas.

While thinking about the issues raised in the above strategy, you may question the basis of our approach. Is this speculation or is there some sort of group of first principles upon which our strategy is based? The foundation of our approach is based on how we use our brains - memorizing, recalling, understanding, thinking and doing. Building our IT infrastructure is based on how global connectivity and our internet-memory facilitates problem-solving in an internet-centric environment. Here are our main ideas describing the neural basis for our approach.

- The basis for a shift to internet-centric learning and problem solving: How I think I think (Internet-memory, a thinking amplifier)
- The way we think about software tools. Enabling GMS learners to innovate
- Early Observations of Data Access and Workflow within MUSC (Jan 1998 - March 2006)
 - Early observations within MUSC: My Job as Minister of Data Transport
 - Early blueprint for IT enabling, with examples

To build an infrastructure, we have developed a set of core policies and definitions. This is a work in progress, but here is the start.

- Our infrastructure policy - a work in progress Growing our IT infrastructure is impossible without a group of creative and talented folks, curiosity driven, and given great freedom to take on any challenge. Using our tool-based approach for crafting 80% solutions to complex problems, the MUSC IT Lab solves more problems in a day than is often possible using traditional software project paradigms. Below are some of the principles directing the IT lab.
- The IT Lab The greatest bunch of friendly folks you'll ever find! They release early, they release often, and what they release is good stuff. It provides the context for a continuous dialog between developers and users - a forum for articulating problems, improving the problem statement and evolving solutions.
- Software Engineering at the IT Lab
- Building browser accessible wrappers around legacy and new databases.
- Command Line Tools for Proof of Concept
- Network Statistics from webperf.org: Measure the time required to download a page
- RSS Validator
- HTML Validator

Thoughts about learning in an internet-centric university

- The basic science of education
- Thinking with Gene Stead about Learning
- Thoughts about an Internet-memory
- When have we learned too much

- In Defense of Cheating (Donald A. Norman)
- Learning and LTP
- Unlearning (forgetting)
- The forgetting curve
- Scientific Teaching (Science 304:521-522, 2004)

Useful Background about Open Source, the role of information cost in a firm and Placing the Client in the Driver's Seat and Legal/Regulatory issues

- IBM Systems Journal - focus on open source
- Groklaw: Why Free Software Really Matters
- Management and Virtual Decentralized Networks
- Three essays by Jack Reeves: Code as Design
- Radical Simplification (Sam Ruby)
- Care and Feeding of "Free Open Source Software"
- Open Source Everywhere (Wired, Nov 2003)
- Andrew Morton on Open Source Development
- Linus on kernel management style
- Great Hackers: or all about people with a passion to execute solutions
- Extending the brain into the network
- How Google will be supreme over the semantic web
- Tim O'Reilly - Open Source, Thomas Kuhn and Paradigm Shifts (O'Reilly Publishing)
- Using open source in real-world software products John Hubbard, Apple Computer.
- Bridging the Gap: Tools acquire meaning in a context defined by process
- Seven open source business strategies for competitive advantage
- Jon Erickson: A Manifesto for Collaborative Tools
- System redesign: the strangler approach
- Coase's Penguin, or Linux and the Nature of the Firm: Yochai Benkler
- Political Process as the cost of information is driven to zero
- An Overview of Ronald Coase's basis of institutional structure
- Ronald Coase Nobel Lecture: The Institutional Structure of Production
- How to Misunderstand Open Source Software Development
- Powerpoint Makes you Dumb
- Edward Tufte: The Cognitive Style of PowerPoint
- A Toolkit for Customer Innovation
- How Open Source Works
- Faster, Better, Cheaper: Open Source Practices May Improve Software Engineering (NSF bulletin)
- Faster, Better, Cheaper ... (pdf)
- Continuous Software Design (pdf)
- MIT Global Software Development Practices
- UC Irvine: Institute for Software Research
- Federal Regulations and Law: Copyright, HIPAA, Social Security, Fair Use
- A crash course in copyright
- Basic Critical Thinking for Software Developers from Hacknot

- Safe computing in a hostile network
- An overview of web services
- IBM DevelopWorks overview of web services

Management

Empowerment is part of the equation - empowering those around to take ownership of solving a problem. Recently (May 09 2004), there was a wonderful article about the potential purchase of Georgetown Steel. Part of the equation was reducing management and challenging employees to accept multiple roles within the organization. To me this is giving employees the opportunity to own major segments of solving a problem - in this case, making Georgetown Steel a profitable concern. NuCor Steel has a similar philosophy as does the IT Lab. It is a nice read.

- Management and Virtual Decentralized Networks
- The Soft Side of a Steel Company - Iverson's Approach to Management
- Georgetown Steel on the Mend (Charleston Post and Courier)

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