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Museums in the Computer Age: meeting the challenge of technology

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Abstract: Several years ago a volunteer group[1] at the Computer History Museum (Mountain View, CA) considered the challenge of presenting and explaining computer software. The resulting discussions led quickly to the idea of using a web site rather than traditional physical exhibits. Further investigation suggested a web site that featured a special online database containing a timeline that highlights milestones from the chosen subject and offers levels of detail and progressive presentations. I believe this approach will allow the patron time to absorb the material and any special vocabulary that might be involved, prior to a trip to the museum.

The approach appears to be applicable whenever a museum wishes to improve its presentation of technical material. In the following paper, I use personal transportation (autos) and computer software as two examples. Other technologies, and even a bit of general history, might also benefit.

[1] The group consisted of Burt Grad, Paul McJones, Bernard Peuto, and the author.

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Is an eMuseum a super encyclopedia, or an extension to current museum practice? I don't know. However, there is an opportunity to use an appropriately structured web site to offer something heretofore unavailable to a broad range of interested individuals.

In passing, note that existing museums have expensive facilities, must deal directly with the public, usually display only a small portion of their holdings at any one time, and at times mount exhibits with special themes. These exhibits are temporary, take a while to plan and organize, and are expensive.

Before going too far, note that art museums are in a different class. These require little preparation on the part of the visitor, and the visitor's physical presence and the ambience of the facility help set the mood for directly viewing the artwork. A wax museum or a museum of automotive specimens require direct viewing of three-dimensional objects, and hence must be visited. Having visited a variety of museums, but not being a professional curator, it appears to me that museums exist in classes defined by their content and purpose.

Now to the subject of my interest: I am interested in representing technology streams, and in museums that present technology to the public. The Computer History Museum is in this class, as are the Smithsonian National Air and Space Museum, the Chicago Museum of Science and Industry, and the San Jose Tech Museum. Further, I am interested in enhancing the education (knowledge transfer) that these museums offer.

A field trip by a bus full of unprepared students is a lost opportunity. The teachers get a day away from the blackboard and the students get to see a local shrine, but the content of such a tour is too light to do much education. A very bright, well-read student might get to view some important artifact that he/she had read about, e.g. the replica of the Babbage Difference Engine currently exhibited at the Computer History Museum. However, to the unprepared or marginally interested student, a traditional museum tour leaves only a light lasting impression. The proposed scheme will provide a convenient, easy way, for students to prepare themselves before they board the bus.

Don't get the idea that I am anti-museum, I'm not. It's just that the traditional museum is a warehouse of artifacts, some are on display, and the displays only slightly stain the intellect of the visitor.

As the subject matter gets more technical, the current crop of museums falls farther behind the ideal of giving the visitor a lasting impression. This is partially due to the unfamiliarity of those who know only artifacts, and partially due to the need to greatly simplify the technical material so the walking visitor can grasp the essence in the short time available as the tour passes a specific point.

Some museums have made an effort to address this problem and enhance a visit. Interactive computer displays are one example. These have a positive impact on the computer literate but require a tour with a flexible time schedule. Further, the visitor who is not literate or can't get access to one of a limited number of terminals or is rushed by the tour guide to "Move On", is likely to feel left out.

Several years ago our group of volunteers investigated mini-auditoriums with active wall displays slaved to a computer so many could view while a few fiddled. These were better than a few terminals, but still short of connecting with those who have varying levels of interest and varying levels of prior knowledge.

An optimum goal would be to educate at a rate customized to each visitor, and this goes well beyond the gee-whiz stage that is offered by the walk-past of an old CDC 6600 super-computer.

In a visit to the Rijksmuseum in Amsterdam I saw an original Rembrandt that was so impressive that all the visitors spoke in hushed whispers. Compare this to a walk past a string of personal computers; even if they had information cards telling manufacturer, date of delivery, mips, and megabytes.

So that is my goal – to better explain the march of technology to the interested visitor. The approach for explaining technology that is advocated involves treatment in levels of detail, provision for time to absorb the material and any specialized vocabulary, and progressive presentations so the visitor/student can probe as deeply as he/she wishes.

From an initial interest in addressing digital computer technology—especially software—the approach could also benefit other subjects requiring a deeper understanding, such as personal transportation (automobiles), public transportation (trains and planes), and utilities (water, power, gas, and communication). In my grandest dreams, applications of the schema would also help to understand doctors, medicine, and public health.

The computer literate will recognize the schema consists of high level timeline narratives for each technical milestone, supported by one or more linked in-depth narrative discussions of important features, with common fundamental concepts cross linked. As appropriate, the narratives can optionally be supported by pictures, videos, music, and verbal presentations. In my thinking, the eMuseum is an extension to an existing museum that better presents the drive of technology. In practice, here is how an eMuseum might work.

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Historically, museums have been created to showcase art, or display historically significant artifacts. Sometimes they have permanent displays, and sometimes they have temporary exhibits focused on specific themes. In established museums there is always a shortage of money, staff, and space. Whenever a temporary exhibit has been displayed for its allotted time, it is pulled down and much of the invested time and talent is lost. An eMuseum will change this equation.

Traditionally, museums have hours and days when they are open to the public. Students, visitors, and researchers must accommodate these schedules and visit the facility during “business hours”. This usually means travel, meals, and sometimes (for the serious), overnight stays. Unless one resides in the same city as the museum of interest, visiting a museum can be costly.

Once the visitor appears at the portal there can be additional expense for admission, refreshment, and special devices to hear the verbal presentations that elaborate on what the visitor sees. A deluxe museum even offers presentations in several languages to accommodate foreign visitors.

A visiting student might have studied the push Westward in an American History class, and hence have sufficient background and vocabulary to view an exhibit of the Lewis and Clark trek of 1804 and understand its meaning.

However, the same approach does not work very well if the subject is modern technology.

With technology, the classroom instructor may be weak in certain aspects of the subject, the students may not have studied enough in advance to have the vocabulary required for the materials displayed, and since all of us learn at different rates, the time spent on a walking tour may be insufficient for good comprehension. Therefore, any museum dealing seriously with advancing technology might benefit from adding eMuseum features to their current offerings.

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The additions for an eMuseum are: The hardware would consist of a standalone server computer (probably on-site, but contracted services could be used), a disk file for the database, an Internet connection, and a few desktop computers to be used as entry terminals. This configuration is in common use today. The added staff to support an eMuseum would consist of a technical writer, a system administrator, and a variety of volunteers skilled in the chosen technology. Special software (pilot versions of which may already exist) would be required to complete the package. It should be noted that a modern museum might have most of the above already in place, with the exception of the special software package. On such a system, several technology streams could be represented so museums could enhance their technology presentations to the public. These enhancements will improve the education (knowledge transfer) that these museums offer.

Before describing how an eMuseum system works, and how it's built, one must first know what it contains and how that information is organized. The Internet software allows an electronic visitor to select his/her subject of interest from a menu of prepared offerings. Once chosen, the subject is presented as a timeline containing *selected historical milestones on the subject* from technological birth to the present time.

Some technical histories written in the past have exhaustively presented *all* activities/events from technological birth to the present. In these presentations, the detail sometimes overwhelms innovation, as the uninitiated cannot separate notable milestones from routine historical activity. The process of milestone selection will require a knowledgeable staff plus assistance from subject matter specialists (probably volunteers). This is no different than the decisions that take place when an exhibit is being designed and insufficient space is available for all the artifacts initially deemed worthy of display.

Whatever the process, a written milestone history on the selected technical subject will need to be prepared and stored in the computer data file for remote viewing via the Internet. Whenever an *important* (invention/breakthrough) development occurs in this time sequence, a focused piece will need to be written which contains further detail on the specific development. This piece will have several standard components: The environment at the time of the development, the person/organization producing the development, a detailed description of the development and how it worked initially (in contrast with what the item may be today), and any *fundamental* inventions/breakthroughs on which this development depends.

For those fundamental advances in technology, additional focused pieces will need to be written; each successively more detailed until the subject is explored exhaustively. At each level of detail, if the museum has artifacts on display, or available for viewing, or available from a previous historical exhibit, these items can be linked to the electronic presentations so a potential visitor knows what holdings are physically available within the museum.

The software will allow these focused pieces to be easily referenced. While holding the viewer's position on the original timeline, the viewer can digress, absorb more detail, and then proceed without difficulty. Modern software can handle multimedia collections of text, music, speech, still pictures, and videos. These can be linked to the main timeline to provide a richer online experience.

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The timeline for the automobile would start with the horseless carriage in 1890. The development that made this possible was the small, light-weight, gasoline engine. In the early days there was competition from steam, diesel, and battery power, but the development that shaped the world as we know it was gasoline. Wikipedia estimates there were once about 1000 car builders in the United States, but if the criteria of "innovative or dominating" were applied, only a few would be selected for the timeline.

A timeline focused on developments of note would mention early automotive racing competitions to prove reliability and stir up the market, various experiments with bodywork and cabin comfort, and then the appearance of the

Model T Ford. The consolidation of many manufacturers into General Motors was a major milestone for manufacture, sales, and service. After some side investigations, metallurgy improved and the V-8 engine allowed higher power in a reasonable sized package. Then, along with the automatic transmission and power assists, the modern car emerged.

Smog and the environment altered the direction of automotive development, followed by efficiency standards and eventually the Prius. In between came competition from overseas manufacturers in luxury, efficiency, and quality.

While this part of the story is pretty well known, these milestones were supported by a series of important technical innovations. To understand the trip from horseless carriage to today's transportation system, a viewer interested in the history of the automobile would first review the Automotive Timeline. In scanning the Timeline, the viewer would note that certain developments were highlighted as being noteworthy technical accomplishments. The following 33 developments would be among those highlighted.

Major automotive innovations.

1. The initial development of the engines (steam, electric, gas, diesel).
2. The first chassis design - engine fwd, 4 wheels, passenger seats, drive train.
3. The pneumatic tire and the demountable road-wheel.
4. The open-wheel racers to prove reliability.
5. The electric self-starter.
6. Four-wheel drive.
7. All-weather roads.
8. Hydraulic brakes.
9. Corporate Mergers and the dealer system.
10. Three noteworthy models : Ford Models T and A and the German VW.
11. Traffic control devices.
12. Licensing and regulation.
13. The V-8 engine.
14. Safety accessories.
15. Comfort accessories.
16. The automatic transmission.
17. Power steering.
18. Limited access roads.
19. Marketing/sales/and styling.
20. Unions and the cost of manufacture.
21. Automobile purchase finance and insurance.
22. Questionable corporate governance.
23. Major foreign manufacturers.
24. Minor foreign manufacturers.
25. Fuel blends.

26. Fuel shortages and economy standards.
27. Politics and regulation.
28. Smog and modern engine controls.
29. Training of service technicians.
30. Foreign designs, US assembly and manufacture.
31. Corporate rescue and World Wide competition.
32. Maturing overseas markets.
33. Electricity and motoring efficiency.

The viewer could review the Timeline and scan the 33 innovations until he/she found one of especial interest. If he/she clicked on button (say) 25 - Fuel Blends, a detailed discussion would appear that discussed anti-knock testing and the determination of octane ratings. Another button click would bring more detail about how engine designs (particularly compression ratios) and refinery capabilities were chosen to produce production engines with octane ratings refineries could produce. If still more detail were desired, another click would bring a discussion of catalytic cracking to produce petroleum products that meet desired octane specifications. One or more final clicks will return up the chain or jump clear back to the departure point on the Timeline.

If the museum had artifacts or documents that explained specific items, the text at any level could be annotated with still pictures, or verbiage by eminent automotive engineers, or short movies that showed vehicles on display in the museum.

Note in passing, with the schema proposed, the offering can be easily expanded as new materials/artifacts are acquired or as additional detailed text is written. Thus, an eMuseum can smoothly grow and expand, something difficult to do with a physical exhibit.

Much of the text can be created when an artifact is acquired. The intellectual effort is about the same as when an exhibit is being planned. It appears that the *cost* of creating an eMuseum entry is about the same as when a new acquisition is being cataloged. The computer work is, of course, additional.

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To the visitor, the advantages of an eMuseum are many. First, the materials are available 24/7. There is no need to travel unless you have reviewed the materials and decided the brick and mortar displays are interesting. A visit can be planned around the hours the museum is open *and* fit the schedule of the visitor. In the case of special technologies, the vocabulary of the field can be learned in advance.

If in-depth study is desired by a researcher, arrangements can be made to view specific physical items at specific times. Fees, if any, can be determined in advance. Finally, the sequence of screen-study-visit will result in a more meaningful learning experience.

In addition to retaining the intellectual investment put into exhibits, being able to easily expand lines of thought, and dealing with a more learned population, a museum may see lower costs for physical maintenance and cleanup, and be able to support a larger collection of artifacts without physically buying more bricks and mortar.

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There are several aspects of an eMuseum that may not be obvious. Here is a list:

1. <u>IMPORTANCE</u> Citizens need to understand the technology on which society depends. For instance, computer software consists of technical threads that are opaque to most people. There are millions of people that use a piece of software in their daily lives without understanding how it works, who created it, or the conditions in the field when it was created. Nevertheless, these users do useful work without knowledge of the internals.

This situation is similar to driving an automobile. Most drivers get reliable transportation from their cars without knowing much beyond filling it with gas, checking the oil, and looking out of the windshield while operating the vehicle. Most drivers do not even check their tires or batteries on a routine basis.

Museums have trouble treating technical topics. The subjects are sometimes ethereal, cannot be meaningfully displayed as an artifact, and have a vocabulary of their own. Some computer users may comprehend ‘source language’, but few understand the transformation to ‘machine language’. ‘Operating system software’ is probably not in their lexicon at all, except that they get a new version from their software house and blindly install it on their personal computer.

Yet, the manufacturer's investment in software is of the same order of magnitude as their investment in hardware; the investment in applications code probably exceeds the original manufacturer's total investment in both software and hardware; and the time the user population spends in installing, learning, and troubleshooting software is enormous. Clearly, software is worthy of better understanding.

In the case of automobiles, many still thought the throttle pedal was mechanically connected to the fuel control, until the Toyota acceleration problems taught us that an on-board, real-time, control computer was involved.

Today there is no ready mechanism for explaining/educating the population of users in technical topics. The books and manuals, of which there are many, merely attempt to explain *how to use* features of a software package or how to diagnose and replace a failing automotive component without making any attempt to explain "how it works, who created it, or the conditions of the field when it was created." Is this important? Perhaps not in text processing software such as Microsoft Word. But math applications, statistics, and any data processing beyond manipulating historical facts, need an understanding of the limits of a software package. You risk erroneous conclusions if all you have is blind faith.

The owner's manual on some cars neglects to treat some emergencies which are unlikely to occur but likely to cause a serious accident if they do occur. Covering every instance of failure is not expected, but more knowledge and more understanding would allow the interested owner access to information that is not now readily available.

A company called DataMonitor published an oft quoted statistic which said that in 2008 the world-wide software business grossed at $303.8 B. I don't know what this number represents or how they got it. The latest US Census number on the size of the software industry is dated 2002 and it is not defined much better. However, with such big numbers floating about, understanding software technology is a worthwhile endeavor.

Without belaboring the point, the U.S. Government once thought the automobile industry "too big to fail".

2. <u>MUSEUM VISITORS</u> Museum visitors fall into classes: the drop-in, the student group, vacationing families, professionals, and researchers. Today, with the

exception of the researchers, most visitors visit a computer museum without preparation. Docents must tire of answering the same dumb questions for each tour group.

If an eMuseum extension were available, and if its availability were publicized, one might expect that a higher proportion of the casual visitors to an existing museum would have more intelligent questions. Further, any visiting scholars could be referred to the eMuseum Internet site on their first contact with the museum, and hence might not come at all if their interests and the museum's holdings were not congruent; or if they set up a visit, their museum contact would be better prepared and could more expeditiously handle their specific requests.

3. OTHER APPROACHES There are a number of museum sites on the Internet that are only electronic, for example (1,2,3,4,5). Several offer (art) history and electronic access. Unfortunately, they are all designed to the same model: Each 'curator' has prepared (or sponsored the preparation of) small standalone independent snippets of history. Each snippet is relatively short and devoted to a single subject. Only one set of them was authored by a single individual and hence can be assumed to use language and word meanings consistently.

In contrast, the proposed eMuseum would use standard language and style standards within a single site, and hence a word found in early computer history and a word used later would more likely have the same (or a derived) meaning. To the uninitiated student or scholar, this would enhance learning.

The American Association of Museums (6), established in 1906, has a publication called *Museum*. In the Jan/Feb 2010 issue, an article by Chris Norris is called "It's Not The Size of The Online Collection". It addresses some of the same concerns as this paper, namely, how to tune museums for the modern (electronic) world.

4. PEDAGOGY Since 1972, Joseph D. Novak has explored a better way of teaching public school students. It is called Concept Mapping. In a nutshell, he thinks significant computer-based improvements in teaching methods are available compared to the chalk-board method which has permeated our school systems for a hundred years.

His work has several facets: A subject matter specialist must devise a framework appropriate to the subject and put it on a computer. Next, the students explore on their own, do some research, and fill in the blanks in the framework. Finally, the students and their mentor meet to vigorously discuss the resulting knowledge space.

Industry picked up on these ideas, and applied them to the problem of retaining corporate knowledge in the face of downsizings, turnover, illness, and retirements. In knowledge-based industries, retaining corporate skills in the face of a long bid-proposal-evaluate-award cycle is critical to delivering what you promised, at a profit.

Somewhere along the line, NASA became interested since they have super-long projects that sometimes exceed the lifespan of incumbent engineers (7). One might say NASA is acutely aware of the need to manage their store of knowledge.

The educational experimenters have created several iterations of an online computer application package called CmapTools (8). This allows the instructor to enter a syllabus depicting the flow of the subject matter (high level outline) and then challenge the students to explore the defined space and prepare entries to fill in the blanks at the nodes or the ends of links. This sounds like a subset of the features that eMuseum software would require.

5. <u>FORGIVING AND EXTENSIBLE</u> Only briefly mentioned earlier was the forgiving nature of electronic museum storage. If a physical museum put up an exhibit, and later found an important element had been overlooked, they would have to decide either to move displays, or continue with what they had planned and include the new element next time. Either way, all the publications and handouts to support the first plan would be obsolescent.

With an eMuseum, the new element could be immediately inserted in the chronological stream and further levels of detail could be added with ease. Thus, for only the small cost of storing the new material, the electronic system could be kept up to date.

Similarly, if additional artifacts were acquired, or existing artifacts were cataloged in more depth, detail could be seamlessly added to an eMuseum to educate and keep potential visitors informed of the richness of the collection.

6. SOFTWARE EXAMPLE Earlier, this paper used automotive transportation as an example of how the online offering of an eMuseum would work. A more cogent example, at least to the present author, would focus on Computer Software.

The timeline for computer software is a bit more complex than the one for automobiles. In computers, there are several threads of development that are important, starting with hardware. Shortly after the manufacturers offered hardware commercially, the difficulty of programming and operating these computers gave rise to software. The first era in the evolution of the computer was marked by improved hardware and then improved software to exploit it.

During this period, there were two threads. The hardware thread was motivated by faster circuits, larger memories, more reliability, and less cost. The software thread attacked program development, operational efficiency, and an increasing breadth of applications (across the spectrum of business, engineering, and science).

Whenever the field seemed to slow, manufacturers offered new input or output devices and software developers followed to support these devices and the new systems they occasioned. In addition, software developers matched the engineering pursuit of bigger and better with an ongoing push to develop applications faster and increase the population of people capable of development.

The middle era in computer history is marked by the rise of software from a supporting position to a position of leadership in the field. As hardware and basic software stabilized, development of new applications flourished. Computer aided design revolutionized manufacturing, and business databases pushed commercial applications to new levels of investment and profit.

In the third era of computer history, communications and personal desktop computer service are noteworthy. These threads sometimes proceeded independently for a while and then crossed and proceeded jointly. For example there were several futurists that dreamed about what computers could do if a programmer had sufficient memory at his disposal and the computer was fast enough to carry out his dream application. In the computer press these forecasts were popular. However, engineers in the lab made these dreams practical, sometimes sooner and sometimes later.

A Timeline of Computing would address the major threads of activity, note when they crossed (were simultaneously supportive of each other), and especially note when a new thread matured sufficiently to be important. The detail would tell the conditions of the occasion. Thus a visual for the Timeline of Computing would look more like a loosely woven tapestry than a multi-year development with stable objectives. If software technology lay within a museum's span of interest, an eMuseum offering might be structured with the following 13 inter-related threads:

1: Subroutines and Utility Programs
2: Operating Systems
3: Language Processors
4: (Large) Ancillary Routines
5: Applications Programs
6: Dedicated Systems
7: Peopleware
8: Education
9: Regulation and Constraints
10: Communications
11: Personal Computing
12: Portable Computing
13: Social Computing.

Historically each thread would have a definite start date (circa 1950 or later), proceed on its own trajectory, and eventually interact with one or more additional threads. When a milestone appeared on each thread, one or more detailed discussions would be written and linked to the main timeline. As stated earlier, modern computer practice can easily handle these drop-down links and returns, along with a multi-level database and online access.

As before the viewer would first reference the Computer Timeline. When a matter of special importance (say Operating Systems) appeared in the Timeline, it would be flagged, and a button would offer a branch to a more detailed discussion. If the viewer took the branch, he/she might find additional buttons offering still more detail or a return to the Timeline. In some cases, several levels of detail would be necessary to encompass all the innovation that supported a function visible on the Timeline.

Further, if an eMuseum offering devoted to software technology were undertaken in the near future, many of the detailed dissertations could be written as first person essays by pioneers.

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All in all, a preliminary examination of the eMuseum *concept*, shows an enhanced educational opportunity, efficiency benefits for both the museum and its visitors, and some internal savings for the museum; all at a reasonable cost.

In summary, any museum which has a server computer installed that is connected to the Internet, probably has their inventory of holdings already automated. Such a facility can add two staff members and organize their inventory into a database to support an eMuseum. In about year, and with the addition of software to search and present the linked files, an eMuseum would be available online.

With access available 24/7, some interested individuals could satisfy their interests at their convenience. Others could prepare themselves in advance for a serious visit, and researchers could determine if their needs were matched by the available collection.

The museum staff would have an organized place to store the knowledge they glean in cataloging and in preparation of exhibits, and adding more information to an existing knowledge base would be easy. Original work would be necessary to create the timeline of selected milestones, but the hidden collection and work of past years would be available and retained for the future.

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