Research Topic For
The Berkeley-Stanford CE&M Workshop

The "Living" 4D Project Model

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Introduction
My vision of how projects should be designed and managed involves the complete integration of the design, procurement, construction, and management of a project in a "Living" 4D Model. I use the term "Living" because I see this as more than just a tool for design and engineering, but also a tool for procurement, construction, and management that is created, revised, and updated throughout the life of the project, taking time (the 4th Dimension) into account.

This is not a new concept. In fact, all major companies either have implemented, or are attempting to implement proprietary systems that would integrate all aspects of design, procurement, construction, and management.

My vision deviates from current practice in that I see this model being developed around a common, non-proprietary, Internet accessible platform open to anyone interested in contributing to it.

My contention is that many solutions will result from a collaborative and open environment within which the imaginative and enterprising developers can flourish and the entire industry will benefit.

Problem
Private companies are struggling with the implementation of proprietary systems because well-intentioned efforts are often sidetracked by company politics and lack of incentive for the worker.

Company politics involves:

- People striving for short-term personal gain,
- Line employees not having the time to develop new tools,
- Companies selecting a single, potentially ill-fitting solution, and
- Managers choosing people for development based on *whom* they know instead of *what* they know.

Lack of incentive results from:

- Employees having little to gain with new developments: the rewards accrue to managers while employees perform the core level work. A prime example is CEOs taking substantial raises while the workers get little or no pay increase.
- Many of the knowledgeable workers being busy on projects leaving only personal time for development work.
- Employees being reprimanded for using non-company approved systems.

The research project:
Development of a common platform to promote the development of software systems for integrating design, procurement, construction, and management. I see this as something along the lines of the Internet. The Internet was a system developed by universities for

improved communication. Being an *open platform,* accessible to anybody, people have let their imaginations run wild, developing applications such as e-mail that not only have expanded our communication capabilities but also have changed our way of doing business. The recent explosion within the Internet Community has been done with the knowledge that if they were successful there is a huge potential for financial gain. Developers have found a niche and catered to that niche. So what better place to undertake such a project than at the university level, the birthplace of the Internet?

The Engineering, Procurement, Construction (EPC) market is diverse with varying needs for each sector:

- Commercial
- Industrial
- Petroleum
- Power
- Government
- Telecommunications

Typical projects have a large cast of specialized design consultants. Beyond the typical Civil/Structural, Mechanical, Electrical, and Architectural consultants, below is an example of those used on Fluor Daniel's new Corporate Headquarters:

- Acoustics Consultant
- Elevator Consultant
- Furniture/Workstation Consultant
- Lighting Consultant
- Audio Visual Systems Consultant
- Network Infrastructure/Voice Systems Consultant
- Security Systems Consultant

Some of the problems that could be solved by implementing a living 4D model:

1. Bidding coordination of complex project when all consultants' designs are in various states of completion.
   - During bid preparation the contractors could be given access to the model via the internet.
   - Bids could be submitted electronically with comparisons and bid tabulations created by the system.
   - This would eliminate the massive paper flow.
   - Post bidding issues about not having "ALL" the information could be simplified.
   - Fair Price estimating could be simplified by linking unit costs to the model.

2. Manual checking of interferences among all the consultants' results in extensive "Requests for Information" from all consultants and contractors involved in a building project. This in turn takes a large staff to manage the information flow and resulting cost and schedule changes.

- Periodic on-line reviews could be held with all interferences tracked through to final resolution, including cost implications.
- The RFI process could be linked to the model providing clear and accurate resolution, subsequent tracking of the impacts, and a history of events.

3. Material Procurement is another area that would see great benefits.
   - Preliminary MTO data could be downloaded as required for material procurement.
   - Quantity variations could be tracked with improved accuracy.
4. Constructibility is often an issue after construction begins but is typically given little attention during initial design, when potential for eliminating cost is highest.
   - On-line model reviews with simulated walk-three's have proven very beneficial.
   - Prioritizing work in fabrication shops could be better planned with the model.
5. Construction status is often hidden from owners to hide problems.
   - The system would require "statusing" for actual work completed, simplifying the reporting of actual progress and providing better forecasting of costs and schedule.
   - This would also benefit owners and consultants contemplating changes because they have an accurate status of the stage of completion and better understand the impacts of changes.
6. Final As-Built documentation and QA/QC documentation typically lags far behind and is often inaccurate.
   - QA/QC could be improved by linking with actual test results and reports to specific items in the model.
   - Updating the model based on the RFIs and changes would result in having as-built documentation on demand.

Imagine the resources required developing a system that could accommodate all the items mentioned above, let alone the unlimited items that could be added to the list. Then factor in the specialized needs of the various sectors. Which single company has the funding and resources to handle such a task? Answer: NOT ONE.

The key dichotomy is the *open system* versus the *closed system*. To illustrate the implications of choosing either open or closed systems, I will use Microsoft and Apple as simple examples. As Apple discovered, the closed (proprietary) system approach works for only a short time. Apple kept the internal workings of its computers and operating systems a secret, allowing only a few select licensees to produce compatible hardware and software. Microsoft, on the other hand, engendered the open system approach, selling the basic platform (the operating system) for a mere pittance and publishing complete documentation for the programming interfaces. Developers went wild creating applications that far exceeded the expectations of the user community--even of Microsoft itself. These new products have increased personal productivity, which turns out to have the largest impact of all available efficiency improvements on total project cost. Thus, my vision of an evolving Internet-based EPC core system takes this concept of open systems a step farther by providing a collaborative environment out of which new and dramatically improved productivity enhancing applications will emerge. As in the

Microsoft example, the functional limitations of such applications will be bounded only by the imagination of those who participate in the project.

The major problem facing all companies is improving efficiency, reducing costs, and providing higher quality products to clients while during a period of ever-increasing specialization within engineering. Add to this the litigation and globalization issues and the resulting collection of tasks becomes daunting. Companies have to get better just to stay in place.

I conclude this paper with a riddle: if applications developed over the past several years have indeed had such a dramatically positive effect on personal productivity, why have project man-hours only decreased slightly during the past 20 years? It is because we in the construction industry are now required to do so much more in the same amount of time. In reality, the level of detail in the original design has been expanded, thereby reducing rework rates in the field, where the majority of man-hours are spent. To achieve further improvements in project man-hours will require development of the so-called *killer app,* which will be facilitated by the open, collaborative environment I have proposed above.

Personal Background, Motivation and work in the proposed area:

My involvement in the EPC industry began while attending the University of Colorado, working as a project engineer in the Denver VA hospital. I later obtained my Professional Engineering License from the state of Missouri while working on the The NWS Doppler Weather Radar Project for Fluor Daniel. Subsequently I have worked on Major Commercial and Industrial projects in the United States, Canada, Belgium, and India.

My motivation for this is based on personal experience watching projects struggle without the best tools, knowing they could be developed if the funding or motivation were available.

While leading the project controls effort on a several major projects I also managed the development of a software system. This system linked an electronic download of MTO data from the 3D CAD system with specifications and estimating charts to generate a field measurement system for tracking fabrication and installation of piping, heat tracing, insulation, and painting. The software was capable of providing data by workpackage, contractor, system, etc. as well as prioritizing the work. The system was used on a $300 million project in Canada, and an $800 million project in Belgium, both with outstanding results. This system was not funded by the company but developed on the project, along with an expenditure of my personal time and that of many others.

I had been asked to implement the system on other projects but logistics got in the way and it was never used again.