

**Chasing the Boulder Down the Hill:
Reengineering and Architecture at the University of Pennsylvania**

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Abstract. Penn is one of the first universities to combine the reengineering of business processes with an information technology architecture. At CAUSE '93 we talked about pushing the boulder up the hill—convincing people to play when the stakes are so high, negotiating consensus, and planning for flexibility. A year later, we're running to keep up with the boulder as it plunges down the other side. Financial processes will look very different at Penn, a data warehouse for management information has been built, and the first pieces of a new client/server financial system will be in place next year. Partnership is still the issue—the pairing of reengineering and architecture, the partnership between the central information technology group and the Division of Finance, and a new set of relationships as the application vendor has joined the mix. And as old boundaries shift in the client/server world, we're finding that the old rules for partnership are changing. This session follows Penn's partnership of reengineering and architecture as it moves from courtship to reality.

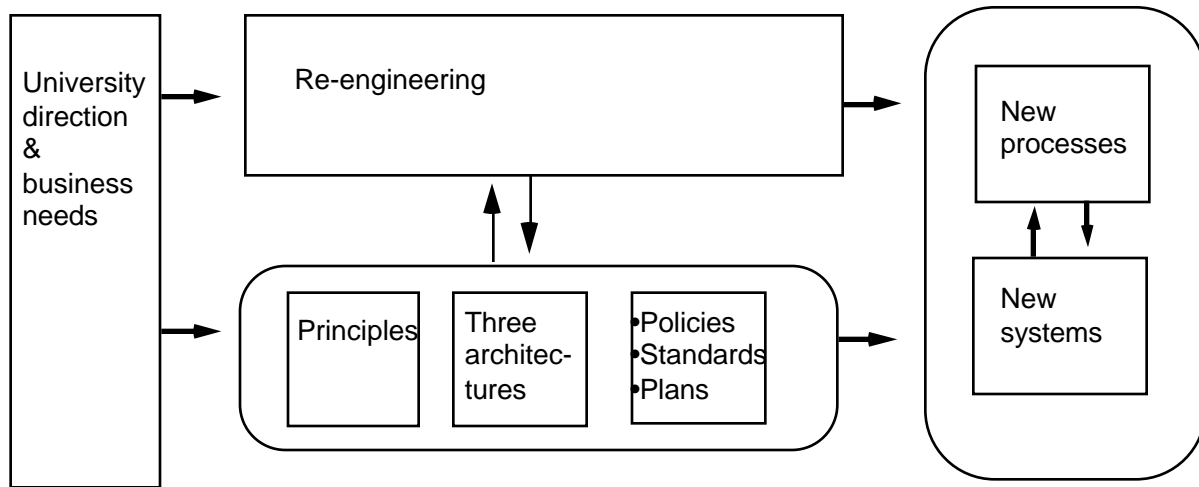
Chasing the Boulder Down the Hill: Reengineering and Architecture at the University of Pennsylvania

Penn is one of the first universities to combine the reengineering of business processes with an information technology architecture. The intent of this multi-year effort, called "Project Cornerstone," is to streamline Penn's business processes and put in place new information systems to help make those changes possible. Cornerstone is a working partnership (keys to each other's offices have been exchanged) between the Division of Finance and Penn's central information technology group. The project pairs two methodologies—Business Process Reengineering, with its techniques for rethinking ways of doing business, and Information Engineering, which establishes an architectural framework.

Since Project Cornerstone began in 1992, Penn has redesigned its purchasing process and its basic accounting structure. We have published principles for using information technology, created a University data model, and defined a technical architecture. We have acquired from Oracle Corporation a new general ledger accounting system and a new purchasing and payables system (to be operational in 1996), along with Oracle's relational database management system and development tools. A data warehouse for management information is in the pilot stage. All will run on Penn's new SP2, a UNIX-based parallel processor from IBM.

Today's talk. At CAUSE93 we talked about pushing the boulder up the hill—convincing people to play when the stakes are so high, negotiating consensus, and planning for flexibility. A year later, we're running to keep up with the boulder as it plunges down the other side. Today's talk focuses on four aspects of Project Cornerstone—reengineering, principles, architecture, and support. We're learning to work with new boundaries and new rules as our complicated new partnerships move from courtship to reality.

Cornerstone machinery. The diagram below suggests the interdependencies that characterize Project Cornerstone. University direction and business needs are the driving force. Administrative processes are reengineered, beginning with Penn's financial functions. A technological foundation is established that includes principles and architectural models. From these flow policies, standards, and plans. The goal is new ways of working, supported by new information systems.



New metaphors. The extensive evaluation process to choose a vendor for the first Cornerstone systems highlighted the new boundaries and new rules we're learning to negotiate. In the past, our vendor partnerships were a little like shopping in a big department store, to borrow a Gartner Group analogy. We went to one store, expecting to find everything we needed. We were familiar with the store; we knew where to find the escalators and where to get a sandwich. We were loyal to the store because it met all our needs. As we evaluated potential Cornerstone vendors, we began to realize that the department store has given way to the mall. Vendors no longer provide *de facto* architectures for their customers. It's an integrator's world, and we find ourselves shopping in the various stores of the mall to pull together a solution. The vendors cooperate among themselves to draw us to the mall where we'll buy their individual products. In that world, our own partnerships with vendors are more fleeting business arrangements, based of necessity on solid negotiation and contracts.

The process of choosing a vendor for the first Cornerstone systems also highlighted the new interdependency of technologists and their business counterparts. The decision points were far too complicated for either side to act alone. The evaluation phase seemed to go on forever, but paid off in mutual learning. It laid the groundwork for the technologists to understand business issues down the road, and vice versa. Both sides began to realize how *hard* the decisions on the other side really are. In the end, the vendor decision was based firmly on business needs as well as technical soundness. This didn't happen by accident; Penn's approach includes a structured evaluation methodology.

Reengineering

Trying on new suits

Penn is a large, decentralized private research university. Many administrative processes have become cumbersome, disjointed, and slow. The division of labor between schools and central groups is not as clear as it could be, and Penn needs to improve its ability to make decisions and make them quickly.

Imagining it. Starting with the purchasing process (the first commandment of reengineering is you have to start *somewhere*), we began to imagine a new way of doing things. Schools and administrative offices will buy and pay for goods themselves, greatly speeding up the results. The central purchasing group will spend its time negotiating with vendors, providing systems and training, measuring results, and generally helping the field—acting as corporate guarantor of quality.

It was hard for the central groups to imagine letting go, to give up their checking and controlling and rekeying. And not everyone wanted to. For the sake of argument, we began playing around with the broader business rules ("OK, suppose the schools own *all* the assets; what then?"). We clarified roles and teased out assumptions as we worked our way back from extremes. We tried variations on a theme ("Say you've got satellite offices out there in the schools.") The old boundaries began to shift as we started focusing on linkages and measures.

It was mostly give and take, but some pushing was necessary. It was hard for some of us in the central groups to articulate the value we bring. If you can't define your own role, however, someone else will define it for you, and it may not be to your liking. So there was always a reason to come to the table.

Making it real. A vision is invigorating, but the time comes to make it real. Implementation is by far the hardest of the three phases of reengineering—diagnosis, redesign, and implementation. Imagining a new process is easy compared to the social and organizational changes required to make it happen. We're finding that reengineering is no more, and no less, than good management. You have to figure out what services you need to deliver and negotiate agreements that are both clear and sustainable. You have to refocus and reward employees. And you have to know when to *get out* of a line of business or adjust an employee relationship that's not productive.

We've learned some practical lessons about reengineering and we'd like to pass on a few. First, you have to have the courage to put a solution out there. Is it perfect? No. Is everything in place? No, and it never will be. But until someone comes up with a better solution, we won't be dissuaded by criticism.

Second, you have to help people see a different point of view, help them get comfortable in different roles. We asked people to try on "new suits," pairing, say, a person who manages research grants with someone from the development office. ("How do you attract funds? Where do you get leads?")

Third, you have to find rewards that work. At Penn, we made it clear that we

would not invest in a new information system without first reengineering the underlying process. People are almost begging to be next in line for reengineering.

And fourth, it's impossible to communicate too much.

Principles

Keeping track of "aha" experiences

At the heart of Project Cornerstone rest twenty-six principles for using information technology, ratified by the Penn community. They include principles about administrative data, applications, infrastructure, and organization, along with a few general principles (see Appendix). The "cost-effectiveness" principle, for example, reads:

Information technology must contribute to the cost-effectiveness of the business functions it supports and must be cost-effective from the perspective of the University as a whole.

We've learned a few things we would do differently if we could start over. First, we would write the principles in simpler, more direct language and we would have fewer of them. If you want people to use the principles, they have to be able to quote them. Second, it's worth asking yourself how the principles are going to *feel*. Some of our principles really sound like Penn; others are visions of what Penn could be. Both are satisfying. Others are a little preachy and didactic, and some come across as Motherhood and Apple Pie.

We've also learned some practical lessons about putting the principles into action. We are well into a number of projects that flow directly from the principles. One is a Data Warehouse for widespread, easy access to management information. A second example is the design of a new network architecture for Penn. As we use the principles to make real decisions in these projects, we're finding that the controversy and intellectual challenge lie in the *interaction* of principles. Each principle by itself seems a little obvious. It's the tradeoffs and interrelationships that are interesting. And now that costs are beginning to be attached to some of the principles, the tradeoffs are etched in sharp relief. In the Data Warehouse project, for example, people are beginning to worry about how much it will cost to have both good security (one of our principles) *and* wide access (another principle).

Second, while it's important to figure out what counts as making the principles official in your institution, that's not the same as making them useful. In our case, "official" means publication in our bone-dry, house journal of record. Our Data Administrator, on the other hand, is particularly adept at making the principles useful. It's an iterative thing, she says; you need a few projects under your belt. "Oh, that's what you mean by 'common base of data' " (one of our principles), people tell her when they hear about the Data Warehouse. She has fifteen other general-purpose, concrete examples that she uses, and she keeps track of "aha" experiences and turns them around on people. She paid a Data Warehouse

marketing call to our facilities director, for example, who was thrilled with the idea that he would soon be able to get information about all categories of people at Penn. She said she wanted to jump up and kiss him because he didn't know it, but he had just bought into the "common base of data" principle. She knows the next time he wants to hold data separately, she can use it on him.

Third, each principle needs at least one champion and a natural home. The principles that seem to be going somewhere at Penn are the ones that have an "owner" (such as Data Administration). It's also important to build in continuity by assigning some of the people who drafted the principles to the projects that bring them to life. These people have used the act of developing the principles to clarify their thinking. That's something valuable; spend that experience on the right people.

Fourth, if you wait too long between ratifying the principles and beginning the projects that flow from them, the community won't make the connection.

And finally, if a concept catches on, don't worry if no one realizes it's "A Principle." While the principles as a formal document may not be widely cited at Penn, the concepts are beginning to be worked and the genre itself seems to resonate. People always seem to be saying lately, "What you need is a good set of principles for that."

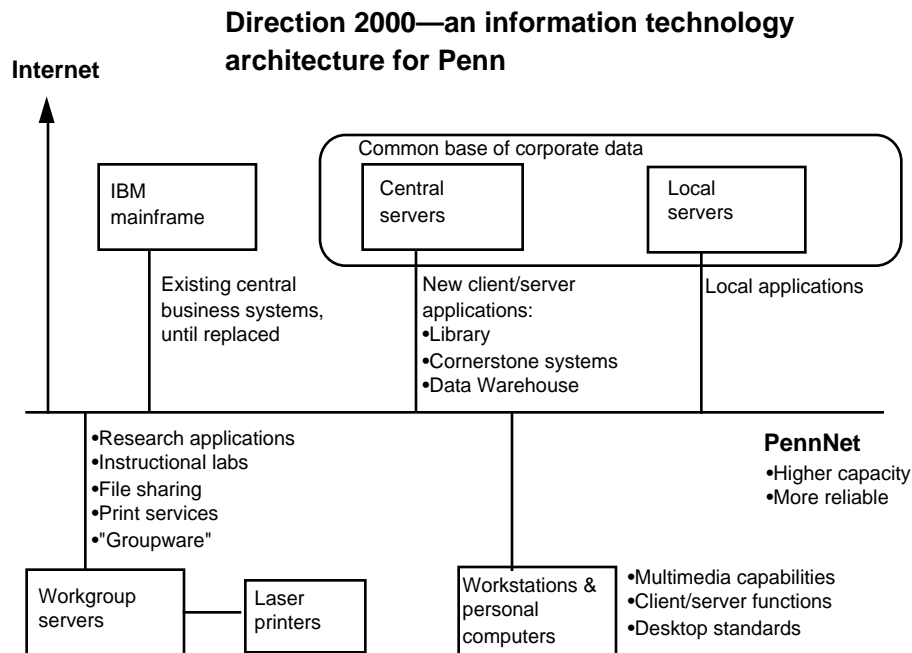
Architecture

An architect's work is never done.

A technical architecture is a blueprint for making technology choices, a guide for acquiring hardware and software. Architecture is more a process than a product—with constant refinement and updating. Various pieces of the architecture are developed to different levels of detail, at different times, and according to different priorities. Penn uses a structured methodology that considers four main areas:

- The University's overall direction and business need (hard to identify in a period of senior management turnover such as Penn has seen in the last few years).
- Information technology principles (see above)
- The state of the current, or *de facto*, technical architecture
- Technology and industry trends.

Penn's technical architecture for administrative systems is known as "Direction 2000." It is a client/server architecture, focusing on servers that provide information, client desktop computers, the network that connects them, relationships with current systems, and the broader Internet.



Place holder strategy. It's easy to feel paralyzed by the enormity of developing an architecture. It's important to decide which pieces to tackle first, which to defer, which to handle in depth, and which to treat cursorily. A place holder strategy helped us come to initial closure at Penn. When "Direction 2000" was developed last year, issues of networking and office automation were treated only at a very high level. We're circling back this year to fill in the gaps. (Penn's Network Architecture Task Force, the focus of another CAUSE94 talk, is one such effort.)

Web of teams. Architecture at Penn is developed by a web of campus-wide teams. Each is working on a different piece of the architecture. Coordination is a major effort. We find generally effective a combination of overlapping membership and the activities of selected individuals who "surf" the different teams to maintain focus and share information. One big challenge is keeping strategic-level groups and tactical-level groups from working against each other.

The "A" word. Some people are uncomfortable with the "architecture" metaphor to describe this level of technology planning. For many, "standards" are easier to understand than architecture. In reality, the terms represent a continuum from the highest level of abstraction (architecture) to the lowest (the actual product buy-lists). "Standards" fall somewhere in between at Penn, providing a practical interpretation of the relevant architecture while usually falling short of naming specific brands and model numbers for purchase. A good example is our new

desktop standard. It is a dual-desktop strategy that recommends minimum configurations of Macintosh and MS-Windows PC's without naming specific models. Support for the minimum configurations is "guaranteed" for four years.

The semantics of standards. We learned the hard way that technologists and many in the Penn business community view standards differently. Technologists see standards as a tradeoff between one technology and another, with the goal of reducing heterogeneity. Many business people see standards as a tradeoff between technology and the absence of technology. For them, standards are raising the floor, forcing people to spend on administrative computing. It looks like a choice between administrative computing and the academic mission. Now we realize that the unusually heated discussions about desktop standards revolved around this point. "Don't tell the schools we have to choose fancy new administrative computers over Bunsen burners," our advisory groups kept saying. "But we're only trying to save you money," we kept thinking.

Support

The boundaries keep shifting.

As client/server computing brings the action to the desktop, familiar boundaries are in flux. The desktop computer and the business system flow into each other, as do once distinct areas of technology. New models of support are required.

Integrated, ongoing training. For users of the first client/server Cornerstone applications, learning to do the new business processes cannot be separated from learning to use the new technology. Penn will integrate the two kinds of instruction, and use local trainers to provide it on an ongoing basis. We believe this train-the-trainer approach, in which a central group provides course materials and pedagogical instruction, foreshadows a shift in the way training will be done at Penn more generally.

Single point of contact. With Penn's new client/server systems, the person sitting at the screen won't be able to distinguish a network problem from a desktop hardware problem or an application problem. Technologists will need to collaborate to support that person, forging new links among network engineers, developers, trainers, and hotline staff. Penn's central computing organization is therefore consolidating its separate help desks (we're calling the new entity "First Call") and establishing channels for drawing on second-tier experts.

Wherever we look, it's new partners, new boundaries, and new rules. These are exciting times to be chasing the architecture/reengineering boulder down the hill.

Appendix: Principles for information technology in administration

General

1. **University assets.** Information technology infrastructure, applications, and data must be managed as University assets.
2. **Functional requirements.** University priorities and functionality determine investments in administrative information technology.
3. **Cost-effectiveness.** Information technology must contribute to the cost-effectiveness of the functions it supports and must be cost-effective from the perspective of the University as a whole.
4. **Policies, standards, and models.** Policies, standards, models, and methodologies—based on the principles outlined here—govern the acquisition and use of data and information technology. Regular update and communication are required.
5. **Investment criteria.** Investment decisions (even those not to take action) must be based on University needs, cost-effectiveness, and consistency with standards and models.
6. **Training and support.** Penn must put sufficient effort into ongoing support of its information technology assets. Skills and experiences from across the University must be leveraged and communication channels opened.

University data

7. **Accuracy.** University administrative data must be accurate and collected in a timely way.
8. **Security and confidentiality.** University administrative data must be safe from harm and, when confidential, accessible only to those with a “need to know.”
9. **Ease of access.** University administrative data must be easy to access for all groups of authorized users regardless of their level of technical expertise.
10. **Multiple uses.** Penn must plan for multiple uses of University administrative data, including operations, management decision making, planning, and *ad hoc* reporting.
11. **Purposeful collection.** A given set of data should be collected once, from the source, and only if there is a business need for the data.
12. **Common base of data.** A common base of data must be created to facilitate sharing, control redundancy, and satisfy retention requirements.
13. **Documentation.** Detailed information about University administrative data must be created, maintained, and made available.

Administrative applications

14. **Ease of use.** Applications must be easy to use for both novice and expert users. Interfaces should be similar enough to present a reasonably consistent “look and feel.”
15. **Adaptability.** Applications must be easily adaptable to changing administrative and technical requirements.
16. **Data sharing.** Applications must use a common base of well defined University data and reference a common repository.
17. **Ensuring data quality.** Applications must help ensure valid, consistent, and secure data.

Infrastructure

18. **Common communications infrastructure.** Academic functions and administrative systems must share common data, voice, and video communications infrastructures.
19. **Connections within the University.** The communications infrastructure must be standardized to allow reliable, easy interaction among individuals, work groups, departments, schools, and centers.
20. **Connections outside the University.** The communications infrastructure must comply with national and international standards that allow reliable, easy interaction with those communities.
21. **Hardware and software choices.** Administrative hardware and software will be limited to a bounded set of alternatives. This applies to desktop computing, application servers, communications components, application development tools, and data management tools.
22. **Emerging technologies.** Penn must devote appropriate, coordinated effort to evaluating and piloting emerging technologies.

Organization

23. **Data stewards.** Data stewards are responsible for ensuring the appropriate documentation, collection, storage, and use of the administrative data within their purview.
24. **Process owners.** Process owners are responsible for developing and maintaining the standards, structures, and applications that ensure the quality and cost-effectiveness of specific administrative processes.
25. **Information Systems and Computing (ISC).** Information Systems and Computing provides leadership, infrastructure, standards, services, and coordination that permit Penn to take full advantage of its information technology assets.
26. **Schools and administrative centers.** Schools and administrative centers are responsible for creating data and using information technology to meet the objectives of their organizations.