APS-I COURSE READER

Project Athena at MIT

Selected excerpts — a project is never just its technology

Schön, D. A., & Rein, M. (1994). Frame Reflection: Toward the Resolution of Intractable Policy Controversies. New York: BasicBooks. Chapter 5, “Project Athena at MIT” (co-authored with Sherry Turkle), pp. 91–128.

This reader gathers selected passages from the chapter into the four turns of the story. Each excerpt is labeled with its source page; the wording is the authors' own. Read it start to finish — about 30 minutes. The complete chapter is posted alongside this file on the course page if you want to read everything.

Why we're reading it. Athena was MIT's roughly $50M experiment in educational computing in the 1980s. We use it as a case study in how a project collides with stakeholders, institutions, funding, and competing ideas of fairness — and ends up something none of its designers intended. As you read, watch four turns: the founders' vision, the controversy it provoked, the redesigns that followed, and how it was resolved — and what stayed unresolved.

Part I — The Vision

How Athena began: a bid to regain MIT's lost leadership in computing by building one technically “coherent” system, in the faith that the right technology would deliver educational results.

— Frame Reflection, p. 91 —

MIT gave the name "Project Athena" to a large-scale experiment in educational computing that it began in 1983, an attempt by the world's premier school of engineering to regain its sense of lost leadership in institutional, especially academic, information-processing systems. Understanding Athena requires a close look at the specifics of MIT history and culture, but the story of the project's development also has much in common with other policy stories discussed in this book. Not surprisingly, the Athena case embodies many features of a classic policy dialectic: institutional designers (in this case MIT engineers and sponsoring computer companies) create a policy object, the Athena system, which they put out into a larger arena (MIT as a whole). There, other actors respond to the object, guided by their own interests and frames. As they compete to control the object, it evolves in ways that differ from the intentions of any one of them.

The case of Athena is made more dramatic by the fact that its institutional actors, its architects and its challengers, held conflicting views of the project that corresponded to pre-existing political and cultural divisions within MIT and, more generally, to pre-existing notions about the relationship between technology and social progress.

— Frame Reflection, p. 92–93 —

Origins (1978–82)

The Athena story begins in the late 1970s, when a series of commissioned task forces produced reports that anticipated much of Athena's design and set out its underlying rationale. The main architects of Athena were in fact the individuals who commissioned these reports, chaired the committees that produced them, and approved of their recommendations, most notably Gerald Wilson, then dean of the School of Engineering, Michael Dertouzos, then and now director of the Laboratory for Computer Science (LCS), and Joel Moses, then chair of the Department of Electrical Engineering and Computer Science (EECS), and now dean of the School of Engineering. All of these individuals were past or present members of EECS, a department that by the late 1970s claimed a third of MIT's undergraduate majors.

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Sensing the loss of MIT's leadership in institutional computing, excited by the educational potential of distributed computer systems, and keenly aware of a window of opportunity created by workstation vendors willing to give MIT large numbers of computers at no cost, these three men conceived of Project Athena. At the core of their conception was the image of a distributed computing system that would be "coherent" —a system of "common interfaces reflecting the language of science and engineering [that] would enable MIT people to share and build upon each other's programs, data, and knowledge." This system was to represent the leading edge of the advancing field of institutional computing. The Athena architects saw the project as the successor to Project MAC, the MIT computer laboratory that had pioneered the development of time-sharing systems in the 1960s and became the Laboratory for Computer Science in 1975. Unique in their day, the time-sharing systems developed at MAC had enabled multiple users to gain simultaneous access to mainframe computing. In the years that followed, MIT played a major role in developing the next generation of institutional computing: free-standing workstations that functioned as "intelligent" computers in their own right. This trend, coupled with the rise of powerful minicomputers (whose performance began to resemble that of mainframe computers and whose cost was a great deal less), made time-sharing systems obsolete. Departments were now able to have their own computers. Athena would balance these centrifugal forces.

— Frame Reflection, p. 94 —

From this position followed three important consequences. First, because the essence of Athena was an effort to regain technological leadership, it would have to use state-of-the-art information-processing technology. Second, because the state-of-the-art is always a moving target, Athena would have to be continually changing. Athena would be a technological experiment for which MIT would be the "laboratory," just as with Project MAC, MIT had been the laboratory for the development of time-sharing. Third, Athena was to be a distributed, networked system that would be a world leader not only in the sophistication of its workstations and the terminals at its periphery, but in the software and operating system at its heart. Athena's architects decided that UNIX, the computer operating system developed by Bell Laboratories and widely considered the wave of the future for "distributed computing," should be the network's standard. The system also would have to be uniformly coherent, not only in its hardware and software, but in the computer languages it supported.

— Frame Reflection, p. 95 —

Indeed, the image of coherence became Athena's technological and aesthetic leitmotif. For its architects, Athena's beauty would lie in coherence, efficiency, flexibility, and universality. The accumulating riches of Athena (libraries of software and dynamic databases) would be continually growing and changing as a result of work done at its periphery. Moreover, Athena would not only provide access to central stores of information but would function as a communications network through which individuals would be able to exchange information with one another and with sources external to MIT. Its power would depend on the excellence of the "complex of pipes" that would make up its infrastructure, designed to be extended eventually to include all of the institute's information processing functions-those related to research, libraries, and administration as well as to education.

This view of Athena reflects a faith that, from the right technology, good things will come. Specifically, it defines an "MIT way" of proceeding with research on technology and education: build the ultimate in technically sophisticated information systems, and they will yield the most powerful educational results.

— Frame Reflection, p. 95–96 —

Although Athena had been originally conceived as a project to serve the School of Engineering, then-provost Francis Low insisted that it be extended to the institute as a whole. He believed that in an undertaking of this scale there simply could not be "haves" and "have-nots." Seeking to comply with Low's policy decision, Wilson and Dertouzos met with Lewis Branscomb, then IBM's chief scientist, and obtained with help from him and others at IBM, a second large donation of computers. They decided to divide MIT into two computational worlds DEC would supply technology for the School of Engineering and IBM would be used for all the rest. Seeking this second gift was to have important consequences. Among other things, we shall see that it created roadblocks to the goal of achieving system coherency.

— Frame Reflection, p. 96 —

The original design for a project in the School of Engineering, now expanded to include the whole institute, rested on several sets of assumptions, some stated, some unstated. For example, the network and the sophisticated terminals attached to it were expected to be available and working with reasonable reliability during most of the period 1983-85, the time-frame of what was declared the original Athena experiment. This turned out to be a false assumption. The technology was late in arriving, and the suppliers often changed their plans for the number and types of machines they could deliver. Large numbers of students and faculty were expected to be willing to pay the price of learning to use UNIX, Athena hardware, and the set of languages that Athena approved for the project: C, Fortran, Forth, and LISP. This turned out to be a false assumption. The designers believed that the standards of the coherent system would not seriously constrain the imaginations or excessively challenge the competencies of the faculty members who were expected to develop new "courseware" for the Athena system. This too, turned out to be a false assumption. Finally, it was decided that to create an educational good in the domain of undergraduate teaching, one should exclude graduate students and the use of computers for research purposes. This turned out to be disruptive because profoundly countercultural: MIT routinely integrates graduate students and research into the undergraduate program.

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Education: the instrumental computer

In sum, Athena's founders thought, for the most part, in terms of the instrumental computer, by which we mean a computer that would be a more efficient educational medium without requiring any change in educational objectives, pedagogies, or ways of understanding subject matter. The computer would be a "useful tool," a phrase that became a universal refrain in the justifications of Athena.

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Software development: a thousand flowers

In this way, Athena's design rested on the belief that, once the network was in place and discretionary resources were made available, a thousand flowers would bloom. It rested on the belief that substantial numbers of MIT faculty would want to invest their time in the development of educational software, and that they would be able to develop it without detracting substantially from their main research pursuits. They would do it, so to speak, "with their left hands." Finally, it rested on the assumption that their imaginations would not be constrained nor their competencies excessively stretched by the challenge of developing new courseware within the parameters of the coherent system. All of these assumptions would be sharply challenged, as we shall see, in the later phases of Athena's development. At the beginning, however, they seemed obviously true to Athena's engineer-architects.

Part II — The Controversy

Once Athena moved into the wider Institute, different groups read it through their own frames — and pushed back over what it was for, who it served, and whether it was about education at all.

— Frame Reflection, p. 100–101 —

Athena's challengers

From the earliest days, Athena had challengers as well as advocates. One group consisted of MIT faculty who were strong advocates of educational computing but highly critical of Athena's style of pursuing it. They did not see the future in terms of a unified computer environment, as all of Athena's founders did, and they did not see the computer primarily in terms of the more efficient teaching of traditional subject matters, a view held by at least some of Athena's founders and emphasized in Athena's actual development. Rather, this first group of challengers saw the computer as a highly personalized conversational partner, an incubator of microworlds for the conduct of thought experiments, and, in Professor Seymour Papert's words, a new repertoire of "things to think with." Rather than focus on the ways in which computers could make traditional teaching more efficient, these faculty members thought that Athena should emphasize the creation of computer environments where students and faculty might come to see and do things in new ways.

— Frame Reflection, p. 101 —

Additionally, there were some who challenged Athena's starting assumptions about technology and education. Professor Joseph Weizenbaum, a computer scientist, and Professor Kenneth Keniston, a psychologist, stressed the opportunity cost of the Athena initiative and argued that one must not confuse technical and educational sophistication. It should not be assumed, they said, that a leading-edge distributed computer network would also be leading-edge in its educational consequences. One of us, Turkle, questioned whether the emphasis on a coherent system would conflict with the richness and diversity of the computer cultures that were spontaneously arising within MIT. She stressed the computer's ability to contribute to, rather than constrain, the natural pluralism of the MIT community. She believed that computers could facilitate a range of learning styles among MIT students and faculty, and argued that the advantages of a uniform and centrally imposed computer environment needed to be carefully weighed against its costs. Finally, Professor Harold Abelson, a computer scientist, was a forceful and persistent critic of what he saw as Athena's overriding technological emphasis. He believed, as he wrote in a 1985 memorandum to the Project Athena Study Group, that

— Frame Reflection, p. 102 —

Although they came to their criticisms of Athena from different starting points, all of Athena's challengers shared Abelson's skepticism about what they saw as the technocentrism of the Athena design. They believed that educational considerations should drive the design of Athena's technological and institutional arrangements, not the other way around, and that Athena's experiments should be designed, at least initially, with an eye to the educational questions raised by the computer. These included: How do computers enter into the process of thinking, learning, and teaching? Specifically, how might computers change how faculty and students think about their subject matter?

— Frame Reflection, p. 104 —

The early debates

Moreover, the challengers and engineer-architects each tended to see the other as a self-appointed elite that threatened to usurp control. For the challengers, the threat came from engineers driven by technological rather than educational vision. For the engineer-architects, it was the humanists, social scientists, and what they called "educationists" were threatening progress in the name of a nonexistent educational theory. Professor Dertouzos lumped these categories together and called them "humano-romantics," good humoredly contrasting them with "techno-romantics" like himself. In a later elaboration of these terms, Dertouzos pointed out that when "confronted with impossible questions," both groups surrender to their beliefs-"the first, in the omniscience of the human spirit; the second... in the truth of science and the miracles of technology." "Devoid of any relevant facts," he went on to say, "either sect is a prisoner of their belief systems, equally encumbered or liberated, depending on the observer's religious affiliation!"

In addition to the champions and challengers, there was a third group among the MIT faculty that might best be called "reticents." This group included some individuals who saw the computer as irrelevant to the real work of education, and others who saw themselves as users rather than developers of existing software. Some reticents had already created computer environments in their departments or laboratories, which were scheduled to be cleared away to make room for Athena. Many of them resented—in silence, for the most part—Athena's intent to root out these settings as though they were slums.

— Frame Reflection, p. 105–106 —

Implementation (1983–86): technical delays

> the worst part has been that in trying to use the computer with students, almost nothing has been even reasonably reliable, ever. Students regularly encountered problems with the system: the computers were down, the terminals were not functioning properly, or something had been changed without any notification. Lecture demos would be planned only to find that the system driving them had been modified and wouldn't work. The programs we wrote were based on graphics and systems libraries which either changed themselves or performed differently as the hardware was changed. Thus we would find that previously developed programs would no longer work properly in the current environment. We not only couldn't rely on maintaining what we had done, but we were given almost no concrete information in order to make future plans. Everything was always in flux, contradictory rumors abounded and little could be counted on.

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Students were the most conspicuous victims of Athena's instability, suffering most immediately from its frequent crashes, bugs, and unannounced changes. Sometimes whole classes would groan audibly at the very mention of the word "Athena." Given the love-hate relationship that MIT's undergraduates have traditionally maintained with the institute (MIT is commonly referred to as "this place"), Athena came to be seen as one more unnecessarily inflicted evil.

Faculty disappointment with students' use

While students complained about what happened to them when they tried to use Athena, many of MIT's engineering faculty were shocked at how students used it. By 1985 it was apparent that approximately 70 percent of the student use of Athena was for things that the Athena planners had pretty much written out of the project as too "mundane" -things like word processing, electronic mail, and computer games. Reactions to this state of affairs among the engineering faculty ranged from amusement to horror. Had MIT procured $50 million dollars worth of equipment and engineered the most sophisticated online time-sharing network of its kind in order to support uses that could have been served as well or better by Macintosh computers or IBM PCs at a small fraction of Athena's cost?

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In the metaphor of the Athena architects, fewer "bright people" had come forward to do "interesting things" than had been expected. The thousand flowers metaphor began to seem hollow.

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Two classes of people

Because of its technical emphasis, it was inevitable that Athena tended to see MIT as a two-class system. The "higher" class, which it favored, was composed of the computer sophisticates, who liked to use UNIX and UNIX-based features such as the X Window System, which permits flexible textual and graphic interaction with many simultaneous tasks. The "lower" class consisted of computer novices, who found UNIX unmanageable, or other faculty members, who considered Athena's advanced features unnecessary to their preferred applications. In the Athena culture, the second group felt devalued. Among humanities professors, for example, Athena reinforced a long-held belief that they were the institute's poor relations.

Resentment over Athena's two-class system was not limited to the humanities and social sciences. It was evident, too, in the School of Science and extended even to some parts of the School of Engineering. Early in Athena's history, when Dean Wilson urged his engineering faculty to come up with more exciting proposals for new courseware, a professor of chemical engineering explained in a widely disseminated memorandum that the Athena community contained two very different subgroups— the "computer community" and the rest of the engineers who wanted only to "teach non-computer engineering with the aid of computers." The latter had little interest in Athena's technical niceties, he thought; they only wanted workable software and had no interest in developing it for themselves. This memorandum reflected a feeling, shared by many silent faculty members who resisted or were indifferent to Athena, that Athena had been undertaken by a small, elite group, without the participation or approval of the larger MIT community.

MIT's incentive system

Even the long-term champions of computers and education were dissatisfied with Athena, which they came to see as a trap for their younger faculty protégés. The history of Athena dramatized that software development, far from being an "exercise for the left hand," was an extremely demanding task. MIT's promotion and tenure process focuses single-mindedly on front-running research in a discipline, and the development of educational software did not count in this system. Faculty members who chose to devote themselves to educational software ran a great professional risk and would find it almost impossible to qualify for advancement.

— Frame Reflection, p. 109 —

The special case of the School of Science

Most of MIT's scientists responded with indifference to Athena's blandishments. As Joel Moses ruefully expressed it in an interview in 1989, "We failed to win the hearts and minds of our colleagues in the School of Science." Indeed, Athena made some science faculty members angry. The Department of Physics, in particular, was a center of resistance to Athena. Some physicists had no use at all for computers in education, finding them a threat to "real physics." Professor Victor Weisskopf, a distinguished member of the physics faculty, was famous for saying, "When you show me this result, the computer understands the answer, but I don't think you understand the answer." Other physicists who did want to use the computer in education, to connect personal computers to laboratory instruments in order to speed up data processing and analysis or to write a computer-based physics text, found their initiatives stymied by Athena's policies, in particular those that restricted choice of machine, operating system, and computer language.

— Frame Reflection, p. 110 —

"Athena is not about education"

As Athena matured, in the period 1984-87, both faculty members and students increasingly voiced the opinion that Athena was not about education but about technology. In chemistry and mechanical engineering, for example, the faculty was astonished that, although computer graphics had been identified from the outset as a major educational opportunity, Athena had failed to develop a usable graphics package. Some faculty bitterly noted that Athena meetings were wholly taken up with technical matters rather than with questions of education. More and more faculty members began to pick up Professor Abelson's original concern that Athena had never addressed the fundamental questions posed by the educational uses of the computer. Why, they asked, was the project being presented to the world as an experiment in education?

Part III — Redesign & Resolution

Facing budget reality and an "explosive climate of anger," Athena's leaders studied the backlash, softened the rules, and reframed the project — around a two-tiered system and a redefined idea of fairness.

— Frame Reflection, p. 113 —

Policy adjustment (1987–89)

By January 1987, as the voices of disaffection grew louder, MIT's administration began to face up to Athena's long-term financial implications. Originally, Athena was to have run for five years as a separately funded project and was then to be incorporated into MIT's normal budget. In its first phase, supported mainly by gifts from DEC and IBM and curriculum development grants from other firms, Athena had placed only a modest demand on MIT's general funds. Now, however, Dean Wilson estimated that Athena's regular future operation would cost MIT between $2 million and $5 million per year, the equivalent of earnings on some $100 million of endowment. The replacement costs for equipment, turning over every five years, would come to an additional $1 million to $2 million per year. It had become clear that MIT would have to support whatever additional curriculum development it chose to undertake out of its own funds; industry resources for this purpose had been hard to get to begin with and now seemed to have dried up. In the light of these hard facts, Provost Deutch asked Wilson to come up with alternative programs and financing strategies for Athena's future.

The PASG study

In 1986, Provost Low had appointed a faculty evaluation committee, chaired by Dean John DeMonchaux of the School of Architecture and Planning, but when Professor Deutch replaced Low as provost, he feared that an evaluation of Athena might undermine the enthusiasm of the founders, which he saw as essential to Athena's success. Only at the insistence of Margaret Mac Vicar, the dean for undergraduate education, did Deutch reluctantly agree to make available a nonrenewable grant of $100 thousand for Athena's evaluation.

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By January 1987, the case study team presented a first working paper to its steering committee. It contained a preliminary sketch of its findings, including a report on the contradictions in Athena's design already described. The steering committee included Professors Dertouzos and MacVicar, and the working paper was promptly transmitted to Dean Wilson. It immediately provoked stormy reactions.

Dertouzos told Schön and Turkle, "The bugs you have detected are of the essence of MIT." The working paper referred to Athena's treatment of the thousand flowers as a "Darwinian" strategy. This, Dertouzos said, was a criticism that assumed a competing, coherent theory of education that did not exist.

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"The MIT way," on the contrary, was to "throw things at people and wait to see who can swim upstream, trusting that the brightest people will produce... the crazy ideas that make MIT great!" As against a coherent theory of education, Dertouzos believed in the beauty of a coherent technical system that would enable a thousand educational flowers to bloom.

Dean Wilson, for his part, was incredulous that he could be seen as failing to promote Athena's educational purposes. Had he not struggled to raise the funds for curriculum development? Had he not made it clear, in word and deed, that he stood fully behind Athena's educational purposes? Moreover, he resented criticism from the nonengineering schools about Athena's design. In many ways, Wilson felt a victim of his colleagues' short historical memory. His design concept for Athena had been built around the needs of the engineering school. He had never sought to serve other constituencies. When Provost Low had insisted, the project had accommodated the administration's demands that it serve all of MIT. It was unfair to criticize Athena for not adequately serving these other communities.

Dean Mac Vicar felt that Athena had polarized the institute. Francis Low had insisted that Wilson broaden Athena to include all of MIT in order to avoid haves and have-nots. Yet in practice Athena had created a two-class system, roughly corresponding to enfranchised engineers and disenfranchised others, thereby producing what MacVicar called a "positively explosive climate of anger." She thought that Athena's designers misread what they had created because they saw it only from the perspective of the enfranchised. "They thought they had an elephant," she said, "and it turned out to be a giraffe!"

Despite anger and hurt feelings, Dean Wilson and his colleagues heard and responded to these messages. Findings of the PASG study that had seemed incendiary when they were first presented - such as the need for greater decentralization of Athena's management, permission for students and faculty to use the technology for technically mundane uses (word processing, electronic mail), and relaxation of the constraints of the coherent system—became accepted in the Athena Executive Committee's discussions as obvious changes to be implemented. The committee developed a new strategy of accommodation, softening the policies that seemed to have provoked the greatest resistance to Athena while taking steps to insure the survival of what it saw as most central to the Athena program. This strategy of "sacrifice the periphery, salvage the core" was pursued in stages.

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The next period of roughly six months (from January to June 1987) came to be known as "Athena's learning curve." While Professor Lerman and Dean Wilson were negotiating the new three-year extension with DEC and IBM, and Lerman headed a committee to plan Athena's next phase, Athena's managers looked for ways to accept what they felt they could not change. They reformulated students' mundane uses of Athena as acceptable as a first stage of involvement with the computer or as one element of a pattern of demand that also included more sophisticated applications. Thus reformulated, mundane computer use was more than tolerable, it was desirable. Widespread faculty disinterest in developing new courseware could be accepted if the metaphor of a thousand flowers were dropped and the focus shifted to the flagship projects. They made peace with the idea that most faculty members who wanted to use computers in their teaching would rely on commercially available software.

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A two-tiered system

Turning the pejorative distinction between "two classes of people" into a basis for constructive action, Athena's policy makers proposed a new model of Athena as a two-tiered system. Faculty outside the School of Engineering who were interested in computers and education would be brought under Athena's umbrella. They would be accepted as "valuable and legitimate," in the words of the report Lerman wrote for the planning committee. Also, they would receive certain network services. Nevertheless, their interests would be categorized as "lower end," in contrast to the "higher-end" uses of engineering workstations.

— Frame Reflection, p. 121 —

Reframing the problem (1989–90)

Along with these recommendations, the committee recognized that the School of Engineering would continue, with funds it raised for itself, to pursue the original Athena model; it would develop state-of-the-art educational computing in a UNIX-based system that preserved coherence in Athena's original sense of the term. Implicitly, the committee seemed to be saying that the institute's priority of maintaining technological leadership would be justified by providing universal access to Basic Educational Services and Tools. In effect, the committee redefined "fairness" in educational computing. Provost Low's standard of fairness, aimed at avoiding a division between computer haves and have-nots, had led to treating Athena as a uniform good, making no distinction between types of uses or users. To the Mac Vicar Committee, "fairness" now meant universal access to a basic level of computer services that everyone in the MIT community could find useful.

Part IV — What It Reveals

The underlying conflict never resolved. The story turns on how designers read — or failed to read — the “back talk” from users, and on competing frames about technology that reveal what the institution itself is.

— Frame Reflection, p. 122 —

The policy conversation

One of the most striking features of the story of Project Athena is the disjunction between the original intentions of its designing system and the meanings constructed for Athena in the context of its use. In contrast to the engineer-architects' expectations that Athena would be used for technically sophisticated and educationally innovative purposes, students used Athena mostly for such "mundane" purposes as electronic mail, word processing, and electronic games. Faculty, who were intended to see Athena as a liberating opportunity, often ignored it or found its coherent system an impediment to their preferred approaches to educational computing. The faculty champions of educational computing came to see Athena a trap for their younger protégés. Science faculty, who tended to see the computer only as a research tool, read Athena as an attempt by engineers to usurp control of the science curriculum. Perhaps most shocking to Athena's designers was that what they had conceived as a grand experiment in undergraduate education should be widely seen as a technological enterprise that was not about education at all.

— Frame Reflection, p. 123–124 —

We use the term "back talk" to refer to messages sent back to policy designers that surprise them by violating their taken-for-granted assumptions and tacit "action frames," telling them, in effect, that the policy object as perceived and used by other actors is different from the one they intended to design and deploy. Actors in a policy arena can listen, interpret, and respond to such back talk in many different ways. How they do so determines much about the reliability of a policy conversation-that is, the extent to which participants in the conversation reliably grasp the meanings intended by message givers and message receivers. In a policy conversation, as in a literal one, reliability of communication is distinct from the degree to which speakers and hearers agree with each other. The outcome of reliable communication is not necessarily a settlement of disputes; indeed, the better the participants understand one another, the more they may become aware of the depth of their disagreement. But reliable communication is a critical condition for the further inquiry that may result in acceptable policy adjustments, or even in pragmatic resolution of policy controversies.

— Frame Reflection, p. 124 —

Marketing, negotiation, or co-design

The choice of policy adjustments faced by the Athena architects may also be conceptualized as a choice between marketing, negotiation, and co-design.

1) In marketing the policy designers treat the policy object as a product and other actors in the environment as a market for that product. They design with a model of the users in mind. But when the users express dissatisfaction with the product, or reject it—"exiting," as Albert Hirschman would say—the designers try to reshape the object in order to give it greater market appeal.

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2) In negotiation designers and other stakeholders make competing claims on the policy object. When actors are dissatisfied with the degree to which their claims are met, they "give voice"-as Hirschman, again, would say—to their dissatisfaction. In this case, the designers treat the expression of dissatisfaction as the sign of a political dispute, which they try to settle by negotiation with the aggrieved parties, giving and getting concessions in order to secure a satisfactory compromise.

3) In co-design the expression of dissatisfaction is taken as an occasion for cooperative redesign of the policy object. The designers seek to involve users and/or other actors in a collaborative design process, in which all parties accept one another as legitimate contributors to the shared design task.

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Frame-conservatism

Athena's founders and champions had this faith. It justified their model of educational reform, and it underlay their belief that once the Athena network was in place a thousand flowers of educational software would be elicited and naturally selected in the traditional MIT way. The design problem as they framed it was to make their technical vision into a reality so that the desired educational consequences would follow. Even if they could not predict these consequences, they saw no reason to believe in a method that put desired effects first. For example, in a reaction to an earlier draft of this chapter, Professor Dertouzos wrote:

> At the bottom of this whole discussion lies, in my view, the basic question of how progress is achieved. There is hardly a person around that can accurately assess the societal benefits of television, synthetic drugs, radar, even gunpowder, decades or centuries after their introduction. Yet you seem to call for assessing the impact of a new technology before it is deployed, and accurately enough to guide its deployment. Has this approach succeeded anywhere in the history of science and technology?

In the end, it was the architect-designers' persistence in seeing their policy object through the lens of their intentions that provoked Athena's crisis of survival. Up to the point of this crisis the designers did not ask "What does Athena mean to its users?" but only "Did it work as we planned?" Policy intentions were taken as surrogates for outcomes on matters as small as Athena's support of faculty salaries and as large as the educational emphasis of the entire experiment. When the back talk was finally noticed, it was read as criticism of the designers' intentions for Athena rather than as manifestations of genuine pluralism within MIT as a social and cultural world. In all of these respects, the story of Athena illustrates a nonreflective policy conversation.

— Frame Reflection, p. 128 —

The dividing line around which Athena polarized MIT is, of course, by no means unique to MIT. Rather, MIT mirrors a conflict of cultural metaframes in our society as a whole. But at MIT this larger social conflict takes on the character of a split between true believers and heretical doubters of a fundamental tenet in what amounts to an institutional religion about the role of technology in society. The Athena story, which exhibits the tenacity of these conflicting metaframes, reveals more about what MIT is than how it has changed.