A Report on Instructional Technology for the Maricopa Community Colleges

It's a River, Not a Lake

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Executive Summary

This report on instructional technology, *It's a River, Not a Lake,* presents two central ideas. The first is, simply, that technology changes.

Not only does technology change within itself, but it changes us. Like a river, technology moves and changes. New technologies become available and older technologies improve or sometimes fade away. Like living on the river, we expect the relative instability of living on the current and we prepare ourselves for surprises. In the context of technology, we have grown to expect the relative instability of the technology marketplace because it is changing so rapidly. The technology marketplace will not allow us to remain fixed at one particular state of the art for long.

This report examines the implications this stream of changes has for a number of issues: the cost of technology and related software, and the increased attention to learning for employees. We have traditionally thought of technology purchases as capital purchases. However, with a replacement cycle of six years, even with intermediate upgrades, we recognize that most of our technology lacks the permanence of many other capital purchases. Once we have committed to the technology stream, it costs every year to stay in that stream, just replacing obsolete technology.

Equally important to the health of the Maricopa Community Colleges, however, is the change in employee development, from a training paradigm to learning paradigm. All employees need to learn more: faculty, PSA, management, M & O, Crafts. No employee comes to the job knowing everything they need to know for the next 20 years. In fact, most employees now spend part of every work day learning. The change of paradigm implies, among many other things, that the employee will be empowered to consider: What do I need to learn to do this better?, rather than the more limiting question now: What training seminars are being offered that I might need?

The second main idea in the report concerns the future of technology, specifically computing technology. The report concludes that we need to regard the network as the computer. The network is what unifies two apparently diverging developments. On the one hand technology is becoming smaller and attending to special purpose needs, as in electronic rolodex, graphing calculators, CD-ROM books, or portable computers. Other developments attempt to unify many media into a single box to create a rich, multi-purpose, multi-dimensional environment. To regard the network as the computer may be the most useful way to approach the future.

It's a River, Not a Lake

Back in the early Eighties – really, before microcomputers were taken seriously – the conventional wisdom for data processing planning was to make decisions (hardware, software, management, etc) that would position your company or college in the mainstream; moreover, to make strategic decisions that would keep you in the mainstream. With that strategy, one would not only be current with the current current, but would constantly adjust toward the center of the flow, neither to be caught in a back-eddy nor flung against the canyon wall on the outside of a sharp turn.

The stream analogy made sense then, as it does now, because a key characteristic of microprocessor technologies is that they are changing. Not only have dramatic changes taken place every few years, but we've every reason to believe that dramatic changes will continue to take place. In computing and related technologies, for example, the operating systems, the basic hardware chip sets, and the application programs will change both incrementally and dramatically.

Neither DOS nor the Macintosh Finder, nor VAX VMS, nor UNIX will be the last operating systems we'll use in our lifetimes. Each of those systems will have a lifetime, during which incremental changes take place, but each of those systems will be superceded by others.

The IBM clone, with an 80x86 Intel microprocessor, or the Macintosh with its Motorola 680x0 processor will not be the last we'll use. They may be the latest and greatest, but not the last.

Over the past 4-8 years, most of us have experienced the turbulence of the computing stream at the application software level. Software upgrades are announced annually, if not more frequently, and always at an additional cost. Competitive products capture the market for a time, only to be supplanted by superior software which takes advantage of hardware not available previously, to offer the user even more capabilities and control.

It's hard to stay in the center of the software stream. Even when you have selected a software product with a long and useful life, that has surely meant changes: incrementally, with each new version; or abruptly, as you realize you can't share files with your colleagues/run under the newer system software version/communicate with the mainframe's newer software versions/ etc. It's especially hard to stay in the mainstream when you've selected application software by companies who later went out of business, or who dropped the product from further development. When no one else is buying current versions of the software you use, that product is drifting out of the mainstream and so are you.

In either case, the result of not staying in the software mainstream (by falling far behind in version upgrades, or by continuing to use non-supported software) is ending up in a back eddy. The back eddy is a peaceful place and not uninteresting at all, for a while. In fact the relative calm is very tempting: "Aha," we think. "Now I can get some real work done." While that is true, the stream keeps right on flowing. And after a while, it's hard to keep contact with our colleagues. They are using different software; we have less in common now. And after too long a time, we've lost touch altogether. And later, when something goes wrong, when the hardware or the software fails, there's no one to turn to for help . The rest, in moving with the mainstream, have forgotten those who stayed behind. The cost of not moving with the mainstream is isolation.

It's a river; not a lake, this experience of ours with technology. While the examples so far have reflected the stream of changes in computing, those who use other technologies will recognize the same dynamics. Consumers of recorded music have been part of a media roller coaster ride: LP record/8-track/cassette tape/CD ROM/ and perhaps digital tape. Have you tried to buy a new LP recently? Producers of music (many of them are artists and performsers) have seen a two-decade change in digitally-synthesized and digitally-recorded sound, and in the control and manipulation of those sounds. Recorded music is being transformed into a genuinely different art form than live music.

It's a river; not a lake. Our behavior, then, and our decisions need to reflect that reality. Namely, we should expect continual revision of the software tools we use. They are not one-time purchases with a one-time learning component. Rather, the software represents a continual cost in both time for learning and expense of upgrades.

The same is true, though it occurs at a slower frequency, of operating systems and computer hardware. We needn't get too attached to a specific hardware model or to system software, because we know that in ten short years neither that hardware nor that system software will be in widespread use. If they can be found at all, it will be in back eddies where they are serving some single-function use. Technology purchases are not one-time purchases. They are simply the latest purchases in a stream of purchases.

Not only do the current technologies change, but new technologies emerge and recombine with the old ones: video, satellite transmission, multi-media, MIDI, and virtual reality.

This technology river is beyond our control. Like the Gila river at flood stage, it makes its own way. Like the Gila river at flood stage, it will not be ignored. It will leave lasting marks on what we do. Like the Gila river at flood stage, it has raised the cost of doing business; it is forcing us out of comfortable homes, out of formerly-secure content and methodologies.

Because it's a river, not a lake, we need to spend part of our energy and resources keeping current with the current, learning enough so that our decisions, vis-a-vis technology, position us in the mainstream. We need to continually update our own knowledge and skills with current hardware and software and their uses, with the current changes in hardware and software, and with the next changes in hardware and software. All this is necessary so that we make excellent use of our past decisions and so that we position ourselves to make quality decisions in the future. Most challenging of all, we are being forced out of old paradigms of teaching and learning; among all else we are being forced to consider and reconsider both content and methodologies. As technologies emerge and begin to influence what we do, we need to explore and evaluate their impact on teaching and learning.

In preparation for writing this report I asked many people the following question: "What will our instruction look like when we have fully arrived, taking advantage of a mature technology?" It seemed like a reasonable question, though few could articulate an answer. It wasn't until I asked the question of Dr. Larry Christiansen, President of MCC, that I heard the truth: that there will be no time of a mature technology. There will always and only be emerging technologies with which we will experiment and put to use in various ways. There will be no peaceful lake of stable resources, only an ever-changing river of new and changing technologies. There is no arrival, only approaching.

Where we are

Did we do what we set out to do in 1986?

As described in the 1986 Master Plan for Instructional computing, we had determined to improve the quality of instruction by integrating computers and instruction.

In 1986 the foundation for the integration of technology and instruction had already been established in three main respects: 75% of the residential faculty were computer literate, a major bond referendum was providing technology funding through 1993, and the colleges were re-wired for voice-video-data transmission into each classroom and office.

The 1986 Master Plan for Instructional Computing estimated that the number of student computers would need to triple by 1991, reflecting a tripling in the number of faculty who would be expecting students to use technology in their classes.

In 1986 we intended that by 1991 students in every discipline would be using computer technology, in the form of tutorials, application tools, and simulations. And we expected that students would come to us from businesses and high schools already computer literate, familiar with several software applications.

In 1986 we expected the future to include instructional applications that took advantage of the network. And we expected students to begin to use on-line, off-site information databases.

In 1986 we thought that the dominant increase in instructional applications would take place on microcomputers, not on the VAX.

In 1986 we thought that instructors would be empowered to develop their own instructional software, using improved development tools that would involve less programming than earlier systems. And we thought that instructors would need better information for making technology purchasing decisions.

In 1986 we understood that faculty held the key to any successful integration of technology and instruction. Faculty would make the wise assessments of the values of technology for their instruction, would choose appropriate technologies, would judge the impact of those technologies on teaching and learning, and would take part in curriculum revision.

To help understand and quantify this focus on the instructor, four stages of technology (computer) infusion were identified:

Stage 1: The instructor is computer literate
Stage 2: The instructor uses the computer for office/professional uses
Stage 3: The instructor integrates computer uses into the existing curriculum
Stage 4: The instructor reassesses curriculum goals and priorities

The two graphs below indicate the computer infusion in MCCCD in 1986 as compared to a projected infusion in 1991.

P.21 1986 Inst. Comp. Master Plan

How did we do?

In 1986 there were about 1200 student micros and terminals (and about 1300 for faculty and staff). In 1993 we have about 9,000 microcomputers and terminals, 4700 for students and 4300 for faculty and staff. The number of student micros has increased four-fold since 1986, just about matching the 1986 expectation.

In 1993 there is practically no discipline that has remained untouched by technology. Indeed, as predicted in 1986, more faculty in nearly every discipline expect students to use technology in their courses. Application software, simulation and tutorials remain common categories of student use, but two additional categories have emerged: student/student communication in course-related discussion groups via the Electronic Forum, and student access to electronic information on CD ROM and the library automation system.

While most students come to the community college with computing skills, it is still not uncommon for students to have never used a computer before. This pattern is likely to continue into the near future, given that so many of our students are adults returning to school.

In 1993 we have over 130 local area networks, connected to each other and to a network of VAX computers by an ethernet backbone. In 1986, the ethernet backbone was in place, but there was perhaps only one LAN connected to it. The intervening years have seen a growth in networks, but faculty and student/instructional use of these networks has developed only sporadically, and not as fast as predicted in 1986. With the increased use of file servers for shared resources and increased use of the Electronic Forum, both of which began to gain momentum in 1991, and in access to the Internet, in which instructional use has only just begun.

Student use of off-site databases has been redirected: in 1993 students gain access via microcomputer to electronic databases on CD ROM in each college library.

No new instructional use of the VAX was predicted in 1986. While this was true for the traditional categories of uses of instructional technology, the EF was developed on the VAX and is still in widespread use on those computers, though it is migrating to UNIX servers. And INFORM, an instructional management system, has followed a similar development path: first on the VAX, later on servers. In fact, it is more clear now than it was in 1986, that the microcomputer is the computer of choice for instructional applications.

Many faculty have developed courseware for their students: tutorials, simulations, testing systems. In some cases faculty have redesigned their entire courses around courseware they've written . And many more faculty have enhanced their courses with technology-related assignments, using popular commercial software.

The chart of the predicted computer infusion for 1991 looks quite accurate from the 1993 vantage point.

Did we do what we set out to do? By many measures we have. We reached a target number of student computers; many more faculty have authored or customized or adopted software for use by their students. Students are more likely to use technology in more courses in 1993 than they were in 1986. But, did we successfully integrate technology with instruction? Or, more to the point, did we improve teaching and learning by the integration of technology with instruction? That, after all, was what we set out to do.

It' seems to me that we have only begun to integrate technology with instruction. Many faculty, in some courses, have shown us some of the possibilities: video tapes which prepare students to set up their Chemistry labs and the use of some dry-lab simulations in Chemistry, Biology and Physics, for example. These technologies can likely be successfully used by even more faculty in more courses. Students, in some courses, use the Electronic Forum to conduct course-specific discussions. Students in many more courses can likely benefit academically from this special, time-delayed, community-building dialog.

But what else should we expect? The technologies are changing; and the adoption of new technologies will always happen gradually. Each new technology will have its beginning, its growth in use, and its transition to new technologies. The Electronic Forum is currently growing in use. The teaching of the COBOL compiler has declined, having given way to the teaching of DBASE and other applications.

Any given snapshot of levels of uses of technology will reveal both its partial adoption and at the same time its possibilities for the future. Any given snapshot will picture the river, with some in the mainstream, some in secondary channels, some in back-eddies; some ahead, some behind.

While I do think that we have only begun to integrate technology with instruction, it is also clear to me that counting is an insufficient measure. We need to know not only the current uses of technology, but we would also need to know how that college or department or faculty member is positioned to take advantage of the next changes; how they are positioned and motivated vis a vis the mainstream.

But did we improve the quality of teaching and learning over the past seven years? And did our adoption of technology contribute to that? While I recognize that these are the important questions, I also recognize the paucity of tools we have with which to answer them. The measurement of the quality of teaching and learning, in particular, seems extraordinarily elusive to me.

In what we can measure, numbers of student computers, numbers of classrooms equipped with video and/or computer projection systems, and numbers of faculty adopting technology for use in instruction, we did accomplish much since 1986.

What we've got and what we're doing with it

To describe what technology we've got is much more difficult than it was in 1986, or in 1981 for that matter. In 1981 only 1/5 of the workstations were microcomputers. Computer users sat in front of a terminal; college users dialed into a mainframe located at the district office. Student users were mostly programming students, though some used MINITAB, and some ran tutorials using an in-house developed authoring language, TEACH. The mainframe could handle about 90 users at a time, though a person could wait 1-2 minutes for a response after hitting (!) the RETURN key.

By 1986 we were comfortably dispersed into distributed computing. A network of VAXes connected administrative users throughout the district. At that time about 1/5 of the administrative desktop units were micros, the rest terminals. Administrative computing applications were distributed on the network of VAXes.

Faculty and students were using, typically, microcomputers. For the most part these were stand-alone systems, not connected to the VAX network, nor networked to each other. In that sense academic computing in 1986 was "dispersed" computing. In 1986 there was, perhaps, only one local area network, in which the chief advantage was a shared laser printer.

In the period of time 1986 - 1993 several developments have taken place. Fueled by funds from the '84 bond, the colleges have made enormous investments in technology.

Among the most important developments, early in this time-frame, were improvements in our technology infrastructure. We invested in an ethernet backbone at each college, rewiring each building to give improved voice and data access to each office and classroom. Broadband systems were installed to provide video delivery across the college. And a microwave network for voice, data and video was built to improve the speed and quality of communications among the colleges.

Characteristics of instructional uses of technology in 1993

1. Student access to computing has improved dramatically. From 1986 to 1992, FTSE (full time student equivalent) increased 40%.

   1981: 156 FTSE/terminal-microcomputer
   1986: 17 FTSE/terminal-microcomputer
   (Note: FTSE fell slightly from 1981)
   1992: 7.7 FTSE/terminal-microcomputer
   (Note: FTSE rose 40% from 1986)

2. More difficult to quantify is the increase in the number and quality and variety of computer application programs that are appropriate for instruction. Students in 1993 still use word processing, spreadsheets, databases and drafting packages. They are still learning to program a variety of computer languages. But they are also using desktop publishing programs, presentation graphics, Electronic Forum, animation programs, and are beginning to use sophisticated Computer Algebra Systems for some mathematics classes.

3. Nearly all faculty and staff have a desktop workstation, usually a microcomputer, as an assumed part of their office furniture. In 1993 less than 1/5 of the workstations are terminals, a reversal of the 1981 ratio.

4. In 1993 nearly all employee workstations are networked, not only to the VAX network as terminals, but also to each other. There are over 100 local area networks in the district, bridged to ethernet, sharing printing resources. Use of file serving is growing, though this remains an underutilized resource.

5. Nine sites have satellite down-links.

6. Nine sites have the ability to send video across the microwave network.

7. Rooms equipped with TV/VCR?

8. Appendix:
*******CHECK THESE NUMBERS FOR 1993******

College Terminals	Fac/Staff Micros	Fac/Staff Terminals	Student Micros	Student student station	FTSE per
Dist180	644				
PC 196	545	7	542	11.7	
GCC	189	505	84	1183	6.6
GWCC	90	274	21	446	3.5
MCC	354	784	33	759	12.0
SCC89	397	21	411	10.4	
RSCC	44	195	0	237	4.6
SMCC	69	195	0	237	5.3
GCGG	46	108	1	209	6.7
PVCC	62	233	0	470	4.4
*EMCCC	0	7	0	50	3.2
District Average					7.7

* figures for EMCCC are from 1993, reflecting the move into new facilities and computer purchases during the 1992-93 academic year.

The Colleges and their technology agendas

Different colleges in the Maricopa District have made strategic investments in different areas of technology. And, not surprisingly, these different investments are adding to the distinctiveness of each college.

For example, MCC has the District's only set of NeXt computers. Since, in addition, MCC trains Motorola employees on SUN workstations, MCC is developing the most experience with UNIX among colleges in the District.

MCC, PC, and EMCCC are working to place the library at the center of academic life, by closely associating technology with the daily business of the library. The library, at these colleges, is reaffirmed as a center for access to information — and much of that information is available electronically. For example, MCC is pioneering network access to multiple CD ROM databases, while EMCCC is basing its future on a CD ROM jukebox, delivering electronic full-text information rather than making heavy investments in print material.

GWCC was an early leader in OE/OE courses and is now a leader in marketing customized technology training to businesses.

GCC, among many other endeavors, is putting substantial resources into courseware, testware and multimedia development, especially in the DOS/Windows environment. GCC is a technology transfer center for IBM. GCC built two instructional buildings which are technology showcase facilities, including a multimedia classroom of the future. GCC faculty and students are the most robust users of Electronic Forum (EF).

PVCC is an Apple Consortium School. With that incentive, PVCC has invested in a substantial amount of courseware development for the Macintosh.

RSCC remains the distance-learning specialist, with audio, video, phone and modem courses offered.

SCC*, SMCC, and CGCC have not emerged into the '90's with an identifiable leadership niche in technology. There is a lot of creative enterprise at work at these colleges. For example, CGCC has made a focused investment in collaborative learning. As a result it is becoming a District model of this teaching/learning approach. In a parallel way, SMCC has become very good at 'human technology', in the words of Ken Roberts, DI.

*I am perhaps too close to SCC to see its niche, but far enough from the others to manage the caricatures above.

Where We're Headed

Possible Futures

Computing hardware is moving in two, apparently divergent, directions: on the one hand is the rich computing environment, sometimes known as the workstation, exampled by the Sun and NeXt computers. On the other hand is the trend to minimalism and specialization, first by portable computers and later by graphing and programmable calculators and Personal Data Assistants (PDAs).

The lure of the rich environment is clear: the power to do everything from word processing to editing video and virtual reality, all in one machine. The rich environment provides a large, high-resolution color screen, a rich application and application-development environment, access to a network filled with resources for doing sophisticated work in a variety of disciplines, ability to connect multi-media peripherals, and the computing horsepower to bring it all together. Current, top-of-the-line personal computers provide the needed power: in the Intel world, the 486- and Pentium-based computers and in the Mac world, the 68040 computers.

The lure of special purpose devices is also clear: lower cost and increased portability make it possible for more people to use more technology more often. The PDA's and similar calculator-size devices are special-purpose, note-taking, personal-organizer computers, with small screens only a couple of inches square. These devices will provide uplink capabilities to larger systems via direct-connect and infrared connections to networks. Graphing, programmable calculators now provide personal, transportable, hand-held capability at a cost not more than the cost of comparable software on computers, without the cost of the computer.

Where do we prepare to invest? Does this divergence represent a fork in the stream, or just a widening of the main channel? In any case the divergence of this character does make it more difficult to identify the mainstream.

The link between these two diverging developments is the network. Both the rich environment and the minimalist environment assume access to a network, at least some of the time. For example, the logical development of the portable computer is the docking computer, where a portion of the base computer is portable, but at the base site one regains access to the network and a larger color monitor. The logical development of the graphing calculator is an upload/download link, not only to similar calculators, but also to base computers, so that programs and graphs can be shared and printed.

Greg Jackson, Director of Educational Studies and Special Projects at MIT, explains that academic computing has progressed through several stages. (Windows on Athena, Volume Two, MIT, 1991) For each stage below, italics are used to indicate how the Maricopa District fits into Jackson's shema.

- **Central**. Large computers provide batch processing to a limited number of users. *For MCCD this period was pre-1980, on UNIVAC computers.*
- **Local**. Large and medium-sized computers provide remote time-shared access to a broader array of users. *For MCCD this period was 1980-present, using the Itel and VAX computers. Administrative computing has remained at this stage, where users are dependent upon the VAX for major applications, while academic computing moved rapidly to the next stage.*

• **Personal**. Free-standing, personal computers are used for diverse office and instructional applications. Everyone, just about, is a user. *For MCCD this period took off in 1984, after several years of experimental use, and continues to the present. This is the characteristic stage of academic computing now for MCCD: not all student microcomputers are networked, though most faculty computers are.*

• **Distributed**. Powerful workstations are connected by high-speed networks to resources across the country. *For MCCD this period has just begun. While network access to faculty and student microcomputers has been increasing since 1986, use of file servers and the Internet is just now building momentum.*

Jackson describes a more ambitious fourth stage (Distributed) than we are experiencing in MCCD. We have many personal computers (not quite the 'powerful workstation' he means) connected by moderate-speed networks, providing a limited set of network services. In Jackson's terms, we are, at our best, at a 'post-personal' and 'distributed', but not 'powerfully distributed' stage of academic computing.

Jackson sees that the imminent next stage of academic computing is **Integrated**. At this stage common applications are used across diverse computing platforms. The X-windows project by MIT is an early embodiment of this stage of computing.

The sixth stage, described by Jackson, is **Linked** — where a high-bandwidth interconnection will carry different kinds of information across the network to each workstation. The successful transmission, recently, of a video clip across the Internet is a portent of this stage of academic computing.

The network will be definite part of our future, even if we're not sure exactly what will be connected to it. In fact, the computer we'll use for academic computing in the future is the network. The network is an emerging technology, a new tool for teaching and learning.

Our future, however, is not sufficiently described by the tools we'll be using. Our future is, really, what we'll be doing with those tools. Marshall McLuhan has said that the content of any medium is another medium. (Understanding Media: The Extensions of Man, p18,McGraw Hill, 1964) For example, the content of film is a novel or play or opera and the content of print is speech. We've experienced something quite similar in academic computing. Early tutorial software looked like books and was described, negatively, as 'page-turning' software.

The first things we can think to do with a new medium are the old things we did. And the appeal of computing was to be able to do those old things faster or better: a faster way to comment student papers, a better way to graph functions. While it was a necessary stage to progress through, I think we're only beginning to move out of that restricted mode of thinking. Having become competant with the new technology, we're getting ready to challenge the conventions and restrictions that our former tools have placed on our teaching and learning. We're just ready to rethink what it was that we really intended to accomplish anyway — and look with fresh eyes to see how we use the capabilities and advantages of the network to fulfill our mission.

In the 1986 Master Plan for Instructional Computing, stages of infusion were described:
stage 1 Computer Literate,
stage 2 Use Computer for office/professional tasks,
stage 3 Integrate Computers in Instruction, and
stage 4 Engage in formal reassessment of curriculum in response to the information age.

The next five to ten years will see a substantial increase in the reassessment of curriculum. I know, for example, that the math departments will be involved in this reassessment, because they have already begun during the 1992-93 year.

	1993	1998
Stage 1	90%	90%
Stage 2	90%	90%
Stage 3	75%	90%
Stage 4	5%	20%

The District Curriculum Committee has called for the review and revision of all curriculum areas, setting an October '94 deadline. Before that October deadline and during the next five to ten years, more disciplines will challenge the current assumptions of their instructional format, including basic assumptions about time and place and duration and mode of instruction, as well as assumptions about appropriate content. And this reassessment will be, to at least some degree, prompted by the capabilities of technology to do more than imitate the old instructional forms.

Getting There is no Simple Task

Productivity

An interesting question was posted recently on a bulletin board in the Math-Science Division at SCC: “Have computers made us more productive?” This is not the question of an active resistor to technology innovation. Rather, it is posed by a long-time user/developer in a Division noted for its long-term commitment to technology. In that context the question needs, I believe, to be taken seriously.

Remove the word ‘computer’ from the question, so it reads “Has ***x*** made us more productive?” To be able to answer that question we need to be able to articulate not only what we mean by productivity but how, and in what units, it would be measured. Now the focus is on productivity, and not on the particular technology itself.

For an individual, increased productivity may be described as doing more in a shorter time, doing work of higher quality, or doing additional tasks that were simply unthinkable (or needed to be farmed out to specialists) in a pre-***x*** era. Using ***x*,** individuals may be able to point to anecdotal evidence of improvement in one or more of those areas. For example, in the mid-80’s I was pleased to be able to prepare better-looking math tests, incorporating graphic elements and typeset quality symbols, as opposed to hand-written tests earlier. The change reflected, I believe, an improvement in the *quality* of the test. But, I have also witnessed improvements in *quantity*, in particular the quantity and speed of communications within the college, across the district, and around the world. E-mail keeps more people in touch on both significant and insignificant issues. While some would argue that the quality of the communication has declined, the telephone and E-mail have combined to put me in closer contact with more people, more often.

Many faculty have increased the quantity of time they have available to their students. Tutorials and simulations (extensions of their instruction), targeted to the students in course they teach, are available to students 17-24 hours per day. I suggest to my students that the tutorials are like an automatic teller. The students won’t get full-service instruction; on the other hand the tutorials are available when I’m not.

For work-groups, increased productivity is often described as doing the same tasks, or even more and of higher quality, with fewer people. The experience of the Math/Science Division at SCC may be typical in this regard. In 1980 we had 14 full-time and 19 part-time instructors with a Division Secretary. In 1993 we’ve grown to 25 full-time and 55 part-time instructors, and 4 early retirees, served by the same secretarial position. This has been made possible by two technology investments: 1) in a network of office computers, where most faculty create their own tests/handouts to final form and 2) in a new phone system which does not demand the intervention of the Division Secretary.

But the anecdotal evidence is not enough, is it? There surely were a few losses along the way. And what were the costs of implementing the productivity tool, ***x***?

> In the Math/Science Division at SCC, we have probably saved hiring additional clerical personnel during the past decade, while maintaining a satisfactory level of service because of technology investments. What have been the costs? Consider $2500 per faculty workstation, replaced every 6 years, for 25 full-time faculty members. This amounts to an annual capital cost of about $10,000 — approximately half the average annual cost of an additional Division Secretary. Even if the desktop computers were only used for office/clerical tasks, they would be a good investment. In fact, many faculty use these computers for directly instructional matters: with software students will use for class assignments, or with professional contacts across the country.

Were the changes worth it? Were other changes also possible? Should we have done even more ***x*** than we did? To answer these questions we need to carefully define what we mean by productivity, in measureable terms.

But that is not enough, either. We need to also address whether the tasks we've been doing are worth doing at all; whether (and how much) they served the larger mission, and at what cost. For example, have my better-looking tests and handouts really served to improve student learning in some way? Perhaps they have given a more professional/ commercial look and feel to instructional materials and, by extension, to the department/ college. And perhaps that has had an effect on student attitudes toward the college academic culture. Perhaps the ease-of-reading has improved student learning. But by how much? And was it worth it? Was the personal touch lost in the change from the informality of the handwritten materials? And what was the impact of that loss?

So there are two kinds of productivity questions: a kind of internal productivity that needs to be articulated and measured. Assuming I want to write a math test, how can I improve its quality (in presentation), shorten its production time and lower its cost of production? And and some larger questions like, "Is giving this test at this time productive for student learning?"

Of course, it's not fair to ask these questions only of technology's impact. What is the productivity value, so to speak, of all the tools we use? These questions are both important and daunting. Clearly a systematic approach is needed to begin to answer these questions. Top-of-the-head answers just aren't satisfying.

To put these questions into perspective, I like to think that the past decade has been a time when we (students, faculty, administration) learned much about the possibilities of computer and video technology for learning. It has been a decade of exploring these possibilities. And in the Maricopa Colleges we've done some serious exploring. What we're finding is that the use of computer and video technology demands persistent training (to be creative in this technology we need to continually improve our facility with it), access to instructional design expertise, access to programming expertise, and spacious gifts of time to reorganize our 'art of teaching'. We've been limited, often, by our own limited imaginations as much as by our limited access to the technology itself.

In other words, we're finding that the use of these technologies places different demands on our time and on the kinds of resources we need.

What is the use of technology like from a student perspective? Students are certainly witnesses to our scattered implementation across the curriculum. But have students themselves become computer users? Does the student who learned to use a function plotting program in physics use it easily in preparing a supply/demand chart in economics, or a demographics analysis for sociology? Or is word processing the only skill that moves across the curriculum! What cross benefits have students experienced? Or do computers and video technology simply reinforce the divided nature of instruction that departments embody?

Said another way, have students become more productive learners because of their uses of computer and video technology?

The issue of productivity is not so crucial when the choices are the appropriate mix of chalkboards/white boards/overhead projectors, because the costs are relatively modest for any of these technologies (and the differences in pedagogies are slight). Productivity, or effectiveness, does become an issue when the choice is the appropriate mix of chalkboard/LCD panel computer projection/multi-media lectern. The differences in costs for outfitting a classroom are so substantial that "instructional productivity" concerns can't be ignored.

In order to successfully discuss the values of technology for instruction we need a vocabulary and a grammar to articulate the bases for our instructional decisions. Then we need a system within which we can evaluate those instructional decisions. And this system needs to be able to distinguish between local, my-classroom-only projects and college-wide implementations.

The Costs of Computer Technology

Once people have access to a computer and related technologies, they'll probably expect to use it regularly. Computer technology has become not only an expected part of each employee's office furniture, but has become, at least partially, integrated into most areas of instruction. It is not unusual to hear in the office setting that "I have everything on the computer!" Nor can most instructors imagine their students without access to the technologies that benefit their disciplines, whether that be tools for research, for problem-solving or for communication. In many and varied ways, we've become dependent on the benefits of computer technology.

Our dependence on technology implies a long-term commitment and a long-term cost. The commitment is to stay in the mainstream, to refurbish and replace the technology as it becomes obsolete. The costs appear both in training/learning time, in the software costs, and in the capital costs of hardware.

The following analysis projects the costs of computer hardware into the future. This projection is based on several assumptions relating to rate of obsolescence, costs per workstation, etc, detailed as follows:

Assumption 1: Computers become obsolete after six year of purchase and will be replaced at an average cost of $2500. Actually, as we look around, we notice that most computers purchased 5 years ago have fallen into dis-use. They haven't run the newer software for years, so they're no longer compatible with the other computers available. In most cases computers that are over 5 years old won't even run the current version of their respective operating systems. (This is especially vexing to students who sit at a variety of computers, in a variety of locations, preparing for a variety of courses. The lack of compatibility in disk size, software version, operating system version, even on computers of the same general class, presents unnecessarily large hurdles to student learning and productivity.) Nonetheless we have managed to find imaginative, special-purpose uses for old computers; so figure an average of six years of use for each computer system.

Some technologies do not change as fast as computer technology. Ten to twenty year old automobiles, for example, will physically wear out rather than outlive their usefulness. Yet even in automobiles we experience the idea of obsolescence. Though an automobile from the 1920's has a certain charm, and though it (and those who keep it running) gain our respect, that car is simply not equipped for urban freeway driving. It still performs the way it was designed to perform, but in our transportation culture, it's obsolete. In contrast, computers often outlive their usefulness - they become obsolete before they physically wear out.

The typical cost of computer systems has been at the $2500 level throughout the '80's. For that $2500 we've purchased increasingly better hardware, moving to hard disks as they became affordable, to hi-resolution color as it became affordable, and to networking as that became normal and expected. Yet our typical system purchase price has not changed radically. For microcomputers put into service during the 1992-93 year, the average cost for a cpu, monitor, keyboard was of $1850, District-wide. We spent about $350 per unit for printers. In fact we bought a laserprinter for each 6 micros during the year. And we spend about $150 per micro for networking, whether it's connected to a terminal server or its Local Area Network is connected by a bridge to the ethernet. So, for 1992-93, the $2500 purchases not only the stand-alone system with printing, but contributes to the overhead costs of being connected to a network.

Assumption 2: The usable life of a computer system can be extended by a mid-life upgrade of $300, on the average. The nature of the upgrade depends on the computer and industry developments. Typical upgrades have been increased memory, larger hard disk, replacement motherboard, added math coprocessor, and added communications or network capabilities.

Most people want to know when you should upgrade an existing system and when it should be replaced. Probably no one knows the answer, but the answer to the following question may help: Does the upgrade put one back into the mainstream? If so, for how long? If by purchasing the upgrade one can then run current versions of software on current operating system versions, and is positioned for the next rounds of version changes, the upgrade is probably worth it. If however, the upgrade leads one further into a niche, or provides only short-term relief, then replacement is preferred.

Assumption 3: Student systems, faculty systems, and staff systems all need to be upgraded and replaced at the rate and cost described by assumptions 1 and 2.

Assumption 4: The costs of mainframe, mini, and server computers, wide-area-networking hardware, terminals, and multimedia peripherals are not included in the projection that follows.

These costs are omitted because the nature (and the costs) of our mainframe/mini computing may change radically in 3-5 years; and because the future growth of multimedia is frankly unpredictable at present. During the 1992-93 year about $600,000 was spent on computer technology that was not directly related to the purchase of individual microcomputers. Included are such items as minicomputers, LCD panel displays, hard disks, tape backups, and switch boxes.

Nonetheless, careful attention and substantial amounts of money will need to be spent during the next decade to insure that our technology infrastructure (especially the network) is capable of supporting the traffic. This money will be above and beyond the projections below.

Assumption 5: Computer systems purchased prior to 1986 (about 600 are currently on the books) will be abandoned without replacement. These are used negligibly now so that the transition to other computer systems will not have much impact on total computer usage numbers. This is an assumption for projection purposes only. Of course, those who now use equipment from that era would certainly feel a jolt if the equipment were yanked away, without being offered a transition path.

During the 1992-93 year, 135 microcomputers were taken out of service, mostly from 1985. Of the 135, most were sold at auction or used for parts by the Repair Department.

Assumption 6: Assume that five years of computers ('86 - '90) will be replaced during the four years '92 - '97. That is, assume that 1000 systems will be purchased each of the four years to replace the 4000 systems from '86-'90.

Given the end of bond revenue funding for technology (and the subsequent failure of the '92 Bond election), this assumption is optimistic. Hopefully, funding for technology will be resumed shortly, so that the indicated expenses are simply delayed, but not changed substantially. The longer, however, that we limp along with obsolete computer systems, the more computer systems will become obsolete, and the more substantial the early next investments in replacement systems will need to be.

Case 1: In addition to the the six basic assumptions above, assume further that the total number of viable computer systems available in the district remains constant.

	Number of Additonal New Units	*Number of Replacement New Units*	*Running Total Number of Units*	*TOTAL COSTS Per Year*	*Running Total of Costs*
1986	*700*		*700*		
1987	*1300*		*2000*		
1988	*700*		*2700*		
1989	*700*		*3400*		
1990	*650*		*4050*		
1991	*1400*		*5450*		
1992	*1000*		*6450*		
1993	*650*		*7100*	*$1,625,000*	*$1,625,000*
1994	*0*	*1000*	*7100*	*$2.920,000*	*$4,545,000*
1995	*0*	*1000*	*7100*	*$2,800,000*	*$7,345,000*
1996	*0*	*1000*	*7100*	*$2,695,000*	*$10,040,000*
1997	*0*	*1000*	*7100*	*$2,800,000*	*$12,840,000*
1998	*0*	*1400*	*7100*	*$3,800,000*	*$16,640,000*
1999	*0*	*1000*	*7100*	*$2,800,000*	*$19,440,000*
2000	*0*	*650*	*7100*	*$1,925,000*	*$21,365,000*
2001	*0*	*1000*	*7100*	*$2,920,000*	*$24,285,000*
2002	*0*	*1000*	*7100*	*$2,800,000*	*$27,085,000*
2003	*0*	*1000*	*7100*	*$2,695,000*	*$29,780,000*
2004	*0*	*1000*	*7100*	*$2,800,000*	*$32,580,000*
			Average per year	*$2,715,000*	

Assumptions:

1. *$2500 for new microcomputer system*
2. *$300 to upgrade a system after 3 years*
3. *Every micro gets replaced after 6 years*
4. *We add NO MORE micros*

Interpretation of Case 1: If all available money for desktop computer systems is spent replacing systems after six years of use, and upgrading them after three years, it will cost $2,700,000 per year, for the entire District. This annual cost extends into the future until one of the assumptions 1 or 2 changes.

This no-growth model means, in effect, that other colleges would actually lose systems as EMCCC inhabits its campus buildings and grows over the next few years. It also means that the ratio FTSE/student-workstation will increase, as the number of enrolled students increases. In short, spending $2,700,000 per year, though it keeps the current fleet of computers at a reasonable level of currency, not only doesn't keep even with an increasing student population, but it also falls short of any increase in the demand to use technology for the existing students and their courses.

Case 2: In addition the the basic six assumptions, assume that we increase the number of computer systems available by 900 per year, Districtwide. This model assumes that we continue thru the '90's the same average increase per year that we have had for the past seven years.

	Number of Additonal New Units	Number of Replacement New Units	Running Total Number of Units	TOTAL COSTS Per Year	Running Total of Costs
1986	700		700		
1987	1300		2000		
1988	700		2700		
1989	700		3400		
1990	650		4050		
1991	1400		5450		
1992	1000		6450		
1993	650		7100	$1,625,000	$1,625,000
1994	0	1000	8000	$5,170,000	$6,795,000
1995	0	1000	8900	$5,050,000	$11,845,000
1996	0	1000	9800	$4,945,000	$16,790,000
1997	0	1000	10700	$5,320,000	$22,110,000
1998	0	1400	11600	$6,320,000	$28,430,000
1999	0	1000	12500	$5,320,000	$33,750,000
2000	0	650	13400	$4,445,000	$38,195,000
2001	0	1000	14300	$7,690,000	$45,885,000
2002	0	1000	15200	$7,570,000	$53,455,000
2003	0	1000	16100	$7,465,000	$60,920,000
2004	0	1000	17000	$7,840,000	$68,760,000
			Average per year	$5,730,000	

Assumptions:

1. *$2500 for new microcomputer system*
2. *$300 to upgrade a system after 3 years*
3. *Every micro gets replaced after 6 years*
4. *We add 900 micros per year*

Interpretation of Case 2: By adding 900 systems per year, and continuing to replace obsolete systems, we would need to spend an average of $5,700,000 per year over the next 12 years, for the entire District. In this model the early years need about $5+ million and the later years need $7+ million, as there are more obsolete computers to replace each year.

Purchasing 900 additional systems per year is probably not a bizarre assumption. The student population will increase substantially, assuming we have more buildings for classes and more faculty to teach. Adding 900 workstations per year would surely improve the FTSE/student workstation ratio over 12 years, as it nearly triples the number of workstations in that period of time. However, the student population may easily double in that same period of time, so that the increase in workstations, even at the 900 per year level, may not actually keep up with increased demand for them by additional instructional applications.

During the '89-'90 academic year, colleges articulated both building and technology needs in preparing the '92 Bond framework. For the time period 1992-1997, colleges anticipated that they would purchase 19,000 workstations, more than twice as many workstations in the same time period as would be purchased according to model 2.

None of the assumptions above included costs for the infrastructure of technology and yet all assumed the viability of the infrastructure. These costs are non-trivial and must be included as a part of the total picture.

In preparation for the '92 Bond Framework, Information Technology Services projected the following system-wide technology investments for the time period 1992-2000:

Data System	$6,380,000
Voice System	3,572,000
Network	1,405,000
Video System	1,400,000
Total	$12,757,000 or about $1.6 million per year.

I have considered another model for replacing our fleet of computers. If we were to replace computers every 3 years, instead of after 6 years, we would realize several benefits: 1) instead of spending $300 to upgrade the computer, we could sell it while it still had some street value, perhaps about $700, 2) we could reduce the size and budget of the Repair Department and 3) our students would always be able to use up-to-date technology.

Unfortunately, it would cost $4.5 million a year instead of $2.7 million a year to replace computers every 3 years instead of every 6 years, assuming the cost benefits of 1) above. The difference in costs increases dramatically if we assume that we would add 300 or 900 units per year. Even at the zero-growth costs, it is clear that the Repair Department is a bargain, since its repair budget (staff and operational budget) is just about $300,000, and that this department repairs the microwave network as well as the phone system, in addition to the computer-related repairs.

Conclusion

"Ignore your teeth...and they'll go away." is my favorite dental aphorism. It's true of technology, too. The cost of not renewing technology, of not staying in the mainstream, is that students and faculty will simply stop using it. The quality of the student's learning experience suffers. The end result is that the students will probably go away, too. Our commitment to technology has substantial on-going costs simply for upgrades and replacement of obsolete hardware; namely $2,700,000 per year to maintain our present state, and up to $7,000,000 per year to maintain our growth of the past seven years. These figures are based on the average cost of $2500 to replace a computer system, the average life span of 6 years for a computer system, assuming a small mid-life upgrade of $300 after the third year. We would increase our costs substantially by moving to a 3-year replacement cycle, rather than the current upgrade and repair model.

Colleges have predicted a need for twice as many workstations than the more optimistic model (2) has allowed for. Not only are the colleges aware of emerging new technologies, particularly multi-media technology, but they are also aware that faculty are requesting more uses of technology for their students, in more courses and more often.

In addition the cost of keeping the computing and communication infrastructure current will add about $1.6 million per year.

Not reported in this anaylsis are the substantial costs of furniture, electricity, nor for software.

The total annual costs for maintaining currency in technology are sobering. But these are simply the costs of maintaining quality. All MCCD students will be using technology in their occupations and/or further studies, and they are counting on us to prepare them for that future.

Training and the Need to Learn

Given the stream of changes in software, hardware and the new technologies with which we do our jobs, continual learning will become a characteristic of our culture. We are not there yet, as the learning of both college procedures and software techniques are often perceived as an interruption rather than as a normal part of our daily work. We take 'time out' for training; we want it to be a one-shot experience. We like the immediate benefits of being able to use a new application program, but we are often irritated when that application is updated and we need to relearn. The attitude that continual learning is somehow only supplemental to what we do must change. In fact it will change. Learning, whether in the form of reading update information, or training workshops, or courses, or degree programs, or in any form, will become a regular part of the work we do.

We will more often ask the question of ourselves and of each other: *What do I need to learn* (to solve the problem)? We don't ask that question frequently enough. We do ask: How can I array all that I know to solve the problem? Both questions are healthy, but the question *What do I need to learn*? opens the door to the Information Age. It is the best question to deal with the climate of change we live in, because, more likely than not, we don't know enough to solve the current problems, even if we knew enough to solve the last ones.

I'd like to spend a few paragraphs on the issue of learning, in the context of what we have traditionally thought of as training and staff development. In MCCD we've done both an excellent job and a miserable job of training. When training has occurred, it's been excellent. Unfortunately, the training has only scratched the surface of what should have been, not only in terms of quantity, but in terms of its strategic focus.

Training Services at the District Office has offered one to three session workshops in a variety of microcomputer application programs, including Intro to the Mac, Intro to IBM, as well as workshops in A1 and Bitnet. Training Services taught 679 different employees over a two year period of time, from July '90 to June '92. These offerings are supplemented at the colleges in a variety of ways. For example, SCC employs technology trainer. Other colleges are building out faculty resource centers in which training often takes place in the context of developing a project, with access to other support resources. In other cases, employees are referred to courses that are offered through the existing college curriculum. Probably most training is 'on-the-job' training, by employees who learn the software applications as they use them.

Training is currently available on a popular, but limited set of topics. The reasons for this are clear. In the first place, the development of training workshops is fairly expensive. For example, it may easily take 280 hours to develop a 7-hour workshop. Because the technology changes, the workshop materials need updating from time to time. This factor alone limits the number of new workshops that can be prepared each year. But in the second place, there are simply too many software applications for any one person to know well enough to teach. As a reasonable result, training is available only on those applications which are extremely popular, and at an introductory level. In fact, there needs to be a guarantee of a sizable audience for the training over an extended period of time, before the training workshop would be developed at all.

Training, over the past few years, has tended to be a backfill type of training, rather than a strategic training. Of course, that's where the largest audiences are. And the need for this type of training is demonstrable. However, introductory learning of current software applications has partially obscured some of the other technology training needs we have which would keep us in the mainstream. For example, I think that the MCCCD community needs desperately to know more about the network we're on, including 120 appletalk zones. And we need to learn how that knowledge can improve access to information that is available on servers within the MCCD District. And then we need to leverage that knowledge into using the Internet. We should be using training opportunities to also prepare ourselves for the next waves of technology changes, as well as making better use of current applications.

Can these ideas merge? That there is an inevitable need for continual learning by all employees (much of which will happen through training) and at the same time the restrictions on throughput that the development of training impose?

What have we learned about Training and Support?

1) The need for training grows; it does not diminish.
2) Development of training materials is time-consuming and is especially difficult for beta version software/systems.
3) College employees prefer training 'at home'.
4) Short 3-10 hr courses fit the needs of many employees.
5) Employees can often benefit from a credit class offering by the CIS dept.
6) Some technology training needs to be provided each new employee: A1 and phone.
7) The most learning happens back in the office when the person tries to put the training into practice. Access to support is very important at that point.
8) Training is one form of support. Support is one form of training.
9) The best foundation for support is a climate where innovation is welcomed and valued.
10) Different kinds of training are needed depending on the person's level of sophistication with the software/hardware.
11) Training on systems needs to be continually provided: FRS, SIS, managing a dept budget, ordering procedures, hiring procedures, etc.

Understanding Change

The following has appeared in the 1993 Ocotillo Report of the *Mechanisms of Technology Implementation and Evaluation* Group, in substantially the same form as it appears below. I have included it in this document because I believe that we need to develop and use a common language for understanding how change works. Further, I believe that understanding how change works is a precursor to making good decisions about how to support technology innovations.

Evaluation of innovations can be pretty risky. Some would argue that too close an evaluation of innovations can have a chilling effect, to the extent that fewer (and tamer) innovations are attempted. And others will counter that we need to learn from each others' mistakes as well as from successes — and how would we know unless evaluations are performed?

The 1993 Ocotillo Group tended toward the latter argument: that we can build on each others' successes and learn from each others' failures, recognizing that evaluations will work best in an atmosphere of trust and support, where they might be disastrous in a hostile environment.

The pages that follow present a description of technology infusion as it occurs within the district. And with this description the Ocotillo Group hopes to present a vocabulary and a schema for talking about technology infusion. (In fact, both the vocabulary and schema apply to many more kinds of infusion than just technology infusion.) And with the vocabulary and the schema, they hope to provide innovators and managers with a common way to think about particular innovations and what those innovations need to succeed.

Two Cultures

Instructional decisions regarding technology (actually, most instructional decisions, at all) take place at the intersection of two different cultures. One is the culture of community and consensus. A department may agree on a text for a course, or the instructional council agrees on a course outline, or the instructors of a given course collaborate on the technology applications that will be used as part of the student's learning experience.

The other culture is that of independent, professional contractor. Most notably evidenced by the large numbers of part-time faculty, but it is also seen in the myriad of small and large instructional judgments that are made by all faculty . The instructor may decide to change the emphasis in the standard course outline. The instructor may decide this semester to include a technology component in a course, as a way to solve an instructional problem that has occurred, only to choose a different solution the following semester.

Given that individual faculty judgment is a strong aspect of the culture, the schema for technology infusion must not ignore the individual. Given that a college is also a community, the schema must also reflect the striving for a sense of consistency and commonalty.

The co-existence of these two cultures implies that we might consider two different schema for describing technology infusion.

From an individual innovator's point of view, one first gets an idea, experiments with it to learn more about it, tries it out on a small scale and, if successful, on a larger scale. During this time the idea may be revised or abandoned if it isn't working out. On the other hand new vistas may appear from initial, tentative uses. In fact, small scale implementations may reveal profound side effects which encourage or discourage further work.

From the organization's point of view - the department or college or district - an innovation catches on sporadically, and over time. Many individuals are first interested in learning about the idea, and later in trying it out. Much later the idea may be in routine use at some locations and, at the same time, other individuals are just getting the idea and wanting to experiment.

Since technology is continually changing, we will always be asking the questions: "What technology should we use? And where? And when?" And for that reason we really ought to come to grips with how we make those decisions. And we ought to set in place procedures and employ methodologies that encourage us to ask appropriate questions, and to avoid inappropriate ones, so that we can support different innovations well.

Schema I: From Idea to Reality

We propose the following schema as a guide in understanding the development of ideas for the application of technology to instruction from the individual's point of view. This schema is intended to be a classification schema. It may be used to develop methodologies and procedures for evaluating technology decisions.

In this schema there are five zones. The first is the zone of *Getting the Idea*. Sometimes this can happen in a reflective state, but it most often occurs in contact with others, both at the college and outside, through conferences, Internet communications, professional journals, the popular press, etc. In MCCCD, Ocotillo has provided one forum for sparking ideas. In any case, an idea hits home, sparks further ideas, and leads the individual to want to learn more.

The second zone is *Learn More about the idea through exploring, reading, research, etc*. In this zone one just wants to see what a given technology might be good for. Perhaps no instructional problem is identified at this point. The goal is just to sit behind the wheel and see where it takes you. In some cases the experiment may be to take a technology developed for one purpose and see if it can be put to other uses. In this zone, a person explores the limits of the technology and gets a feel for its potential uses. If the technology is being used elsewhere, the fastest way to learn may be to combine individual exploration with a close examination of its current use.

Zone three is the *Small Scale Implementation*. After playing with the technology, a potential use may be identified. The small implementation is a live test of that potential use. This test may be as modest as a single assignment in a course, or as extensive as a theme around which a course is organized. However, the small scale implementation rarely involves more than a single instructor in a single course. Small scale implementations tend to be idiosyncratic and contain high levels of personal involvement and time commitment. In this zone, the instructor often measures success by student outcomes as well as by the ease with which it fits into the rest of the course structure.

Zone four is the *Large Scale Implementation*. Having experienced success in the previous zone, we're ready to involve other instructors, perhaps in several courses, perhaps at several colleges, in the innovation. This implementation contains an entirely different set of risks than the small implementation did. The other faculty may not be true believers, nor even familiar with the idea at all. Success in zone four depends on resolving issues about appropriate training of those involved, suitable standardizations, and support needs. Success depends on the proper organization of materials, keeping to a common timetable, and establishing procedures so that the idea can be self-sustaining. Success in zone four is more difficult to measure. Student outcomes and faculty perceptions are important, but so are an evaluation of the procedures, standards, and budget.

In Zone five the instructor and others are *routinely using* the idea. It is now self-sustaining and supported by the normal operational budget. Faculty and students are comfortable in the regular use of the idea. In fact, they expect to be using it.

Within each zone, faculty and other initiators revise and rethink the idea in the context of current experience. Even in the idea stage, a person is alreadycustomizing it to their own purposes. Some projects never develop beyond the small scale implementation, but are continually revised and improved at that level.

Schema II: Adopting the Innovation

Substantial changes happened in zone four of schema I. The challenges for success in that zone had more to do with involving, training, and coordinating the work of others, than directly with the innovation itself. In many respects it moved out of individual decision and control to a more community effort. In fact, preceding the move to zone 4, there was probably a group decision to attempt the large scale implementation. For this reason, the focus on the individual is inadequate in zone four; we need a schema which can give us insight into the movement of the idea through a community. CBAM (Concerns Based Adoption Model) is a schema which has been used for precisely this purpose: to understand the process by which an innovation moves through an organization, in the context of a large scale implementation. CBAM is a comprehensive, grounded, tested and complex system, developed over many years. It provides both a theory and a framework for understanding the dynamics of successful implementation of any innovation in an organization.

Those who are familiar with CBAM can use its concepts and vocabulary to shed light on some of the issues that arise in zones 1-3 of schema I, but its main focus is: Now that we've decided that innovation X is valuable, what do we need to do to get X into routine use?

During the early stages of a project, an individual may define and redefine it many times as its salient features become clearer and as it meets the reality of student use. These salient features, however, are difficult to change once in zone 4, Large Scale Implementation. In fact it is crucial to success in zone 4 that all participants have a clear understanding of the "expectations during the initial implementation phases." (Taking Charge of Change, Hord, et al, Association for Supervision and Curriculum Development, Alexandria VA, 1987, ISBN: 0-87120-144-5) CBAM uses the concept of **Innovation Configuration** to clarify and communicate the variety of ways the innovation can be implemented successfully, and it clarifies the critical components of the innovation. During the implementation, the innovation configuration can be used as an evaluation guide, both to promote the success of the innovation and also to address the question of how well the innovation has been implemented in terms of its own description of success.

CBAM is based on several assumptions about change:

1. Change is a process, not an event.
2. Change is accomplished by individuals.
3. Change is a highly personal experience.
4. Change involves developmental growth.
5. Change is best understood in operational terms.
6. The focus of facilitation should be on individuals, innovations and the context.

This focus on individuals becomes apparent when looking at two different dimensions of CBAM: Stages of Concern and Levels of Use. CBAM identifies seven Stages of Concern:

0: Awareness	I am not concerned about this innovation.
1: Informational	I would like to know more about it.
2: Personal	How will using it affect me?
3: Management	I seem to be spending all my time getting material ready.
4: Consequence	How is my use affecting students?
5: Collaboration	I am concerned about relating what I amdoing with what other instructors are doing.
6: Refocusing	I have some ideas about something that would work even better.

These Stages of Concern can be used by the leaders of the innovation, as well as the participants, to identify small successes and failures, to plot the progress of the large scale implementation, and to determine intervention strategies to improve the chances of success.

CBAM includes another dimension of describing the process of adoption of the innovation: Levels of Use. There are 7 levels of use:

Level 0:	Non-use
Level I:	Orientation
Level II:	Preparation
Level III:	Mechanical Use
Level IVA:	Routine
Level IVB:	Refinement
Level V:	Integration
Level VI:	Renewal

According to the CBAM model, people tend to move sequentially through the levels of use from 0 to IVA. At that time most remain in routine use, while others may move “back” or “forward.” During the infusion of the innovation, leaders will offer different kinds of information and workshops as people move through different levels of use.

CBAM works as a tool for guiding the infusion of an innovation, once the decision has been made to infuse.

Limitations

1. Schema I looks too linear. And this linearity makes the inadvertent judgment that to be further along the scale is better. Reality is much more recursive than this schema indicates.
2. Schema I leaves the distinction between small-scale and large-scale implementation rather ambiguous. Until the schema is tested against more real innovations, this is a limitation. However, it may turn out to be an advantage in terms of flexibility.

Recommendations of the Ocotillo Group

1. We recommend that the group which began discussion of change, during summer 1992, be reconvened to discuss and challenge the effectiveness of these schema for the Maricopa reality.
2. We recommend that this Ocotillo Group continue during 1993-94 with three purposes:
   a. to refine schema I in the context of the Maricopa experience and considering the limitations described above.
   b. to deal with the question: “How do we make the decision to implement a project large scale?” (And by inference, how to we decide to not implement projects?)
   c. to develop a plan for instructing innovators, chairs, deans and managers in the use of both schema.