Keeping Innovation at Apple

- or -

Growing Up without Growing Old

Steve Perlman,
Apple Hacker

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Contents

A Reader's Roadmap

The document is roughly organized in order of decreasing importance. If you have a total of approximately:

5 minutes, read the Executive Summary to get an overview of the document,

8 minutes, also read the Preface and Introduction to get some perspective on the purpose of the document,

25 minutes, also read sections Singular Vision, Leadership of Focus, and Compromise without Compromise to get through the main points of the document,

55 minutes, read the entire document.

i. Executive Summary

This document is a white paper on the subject of technical innovation at Apple. Chapters 1 through 3 discusses the interplay of vision, leadership, and compromise which leads to innovation. Chapters 4 through 7 looks into the character of Apple innovators and the difficulties they face. And, chapter 8 offers some recommendations for change.

1. Singular Vision: 1) Our working definition of innovation at Apple is achieving amazing technology, great user experience, and low cost. 2) Vision is an essential prerequisite to innovation, that defines the parameters of the problem. 3) Vision exists at many levels from corporate vision to subsystem vision. 4) The most important aspect of vision is singularity; a single, compelling vision that everyone follows is essential. 5) The objectively "correct" vision does not exist.

2. Leadership of Focus: 1) Leaders function as parabolic dish antennae, beaming back to R&D a focused vision distilled from ideas and results from within and outside of Apple. 2) While the vision may change with the discovery of better ideas, at any given time it must be an unwaveringly singular, compelling, and decisive. 3) A leader must have the wherewithal to transcend the corporate hierarchy when necessary to guarantee the implementation of a vision. 4) Leaders must be respected by their people, not just their superiors, to be effective.

3. Compromise without Compromise: 1) Compromise comes in two forms: Vision compromise when a product's implementation does not realize the potential of its vision, and technology compromise when a product is implemented using pared down or simplified technology so as to reduce cost or improve performance. 2) Technology Compromise without Vision Compromise = Apple Innovation: making trade-offs like crazy in the technology, but no concessions to the vision is Apple's legacy. 3) Today, "no compromise" has come to mean no technology compromise, often at the expense of vision. This leaves little room for innovation. 4) We need to cultivate a centralized architectural strategy with rich abstractions that comprehend new application areas (e.g. multimedia, portability, low cost). With a centralized strategy diverse R&D divisions can know what technology compromises make sense in the overall vision, and innovation will be possible.

4. Passion to Create: 1) Innovation is a complete commitment of mind and spirit, an all-consuming passion. 2) Innovators are not geniuses at everything; often they are limited in interpersonal skills. 3) Apple needs better mechanisms to deal with conflict between highly creative people. 4) Apple's incentive plan for patent awards and bonuses is often demoralizing. 5) Innovators cannot function in a politically-charged environment.

5. Fellow Citizens: 1) The original work of Apple Fellows has had a great technical and inspirational impact on R&D. 2) Only one of the three active Fellows is home-grown from Apple, and he was appointed seven

years ago. Appointment of a deserving person from within Apple would be an asset to the program. 3) Apple should consider appointing guest researchers temporarily to the position of Fellow.

6. Smart Women: 1) The similarities between men and women engineers far outweigh the differences. 2) Managers (who are almost all men) providing fatherly guidance often treat young men engineers like sons and young women engineers like daughters; while the men are given challenges to test their mettle, the women are protected from failure by being given progressive tasks. 3) Women need to be treated like "sons" to have opportunities to realize their potential. 4) Understanding how women and men work together is an ongoing task.

7. The Salieri Syndrome: 1) A Salieri is a pathologically jealous person who preys upon innovators and innovation. The name comes from a character in the play and film, *Amadeus*. 2) Salieris operate by cultivating the trust of innovators, then undermining their credibility behind their back. 3) Innovation rarely survives a Salieri's political maneuvering in today's Apple. 4) Salieris cringe in the light of mutual trust and respect. The only way to stop them is to detect them early, and then to all stand as one against them.

8. Recommendations: 1) We need an architectural organization for each product family, made up of architects appointed from each constituency in R&D. 2) The architectural organization shall specify the vision for each subsystem, coordinating them all into an overall vision for the product family. 3) We need an organization of counselors trained to work with highly creative people to make recommendations on how teams can more effective. 4) We need to overhaul our incentives program. 5) We need to require new managers to take training and evaluation courses before they are allowed to manage people.

ii. Preface

The better part of valor is discretion.

—Henry IV, *William Shakespeare*

This paper is about Apple making the transition from adolescence to adulthood. It is about how hard it is to retain wonder, enthusiasm, and playfulness while shouldering new burdens and responsibilities. It is about growing up. As with all major transitions in the life of a company, this period of change is a time of vulnerability and heightened sensitivity. So, with the close, hard look this paper takes at the growing pains we face, we must be very careful in how it is distributed for it to have the positive effect that was intended. And, we must be certain that it is not leaked to the press where its words will be distorted and used against us.

Consequently, for the time being this paper will have a very limited distribution. We do not want it to be copied. Let me know if you feel there are a few other individuals who really have a need to know, and I will see that they have a chance to read it. We appreciate your discretion.

Although this is a long treatise on the subject of innovation at Apple, it is by no means complete nor completely correct, and it is certainly not intended to be the final word. Indeed, it will hopefully serve as the first words of a dialog that I believe we need to start among ourselves to return Apple to its place as a world leader in innovation. If you have comments or criticisms, I encourage you to send them to Applelink PERLMAN. I will forward them (if you wish) to the people who have copies of the paper.

I've taken great pains to express my thoughts and criticisms about Apple in a positive, constructive manner. However, because I am addressing real problems which sometimes come about from real mistakes, I am not always able to be as tactful as I would like to be. Also, while I've made every effort to review individual sections with relevant Apple people, there may be some errors that slipped through which we did not pick up. If a section rubs you the wrong way for the above reasons or for any others, please accept my apologies and link your comments so that I may update the paper and make it more constructive and accurate.

Finally, I want to point out that this document exclusively addresses technical innovation within the R&D organization, and even then it only addresses issues with which I am familiar. This is not intended in any way to belittle innovation and creativity which occurs in other parts of Apple; it simply is focused on subjects that I felt qualified to analyze in some reasonable depth. So, whenever innovation is mentioned in the document, it narrowly refers to technical innovation within Apple R&D, not innovation in general, and bear in mind that the scope is limited to my own experience.

iii. Introduction

Fellow Citizens, we cannot escape history. We of this Congress and this Administration will be remembered in spite of ourselves. No personal significance or insignificance can spare one or another of us. The fiery trial through which we pass will light us down in honor or dishonor, to the latest generation. We—even we here—hold the power and will bear the responsibility.

—Abraham Lincoln

Apple without innovation is not Apple. Innovation is the soul of this company whether or not we care to acknowledge it. Our customers believe this, the press expects this, and our PR folks are happy to reassure them if they get doubtful. Somehow, however, within the hallowed corridors of Apple we seem to have lost that arcane incantation to call up innovation's spirit. What happened to the great Apple breakthroughs? What happened to the radical approaches? Why do so many new products look like incremental refinements on old ideas? Why are there no new Apple Fellows?

Like most of you I believe fiercely in the Apple vision. Our mission to change the world. Our commitment to define the model corporation for the 21st century. Our belief in an old-fashioned concept called "Values". Through my technical work, my inventions, my presentations, my promotion of innovation, and my support of women engineers, I have been in the center of progressive R&D efforts, technical and social. I am keenly aware of what is happening on the front lines. And, I am keenly aware of how incongruous it is against our self-image as a haven for innovation.

This paper contains my sincere hopes for rekindling innovation at Apple. Although the ideas presented here probably ring chords from other people's experience, this is specifically an analysis from a personal perspective, that of an Apple Hacker. For five years I have given my everything to the Apple dream, my time, my energy, my spirit. I have watched many people's attitude toward innovation grow from resistant and cautious to belligerent and resentful. I have seen the power shift gradually from creativity and inspiration to politics and manipulation. As the corporation has grown larger, I have watched senior management grow increasingly distant from what is going on. I can't be certain that what I have to say here will change this trend, but just maybe it will. I've got to try.

I started this paper with a quote from Old Abe because President's weekend fell in the midst of the current crisis at Apple. I think his wisdom is very applicable. Apple has a responsibility that goes way beyond the employees, shareholders, and customers. It is a responsibility to posterity to prove that a company like Apple can get big and still thrive. Either we do the easy thing and become like every other hulking American company, bloated, sluggish, and boring. Or, we prove it is possible to be sleek, nimble,

and exciting, even as one of the largest institutions on the planet. Xerox stands as a stark example of a what will happen if we fail. We cannot escape history. We will either be remembered as the caretakers who let this great dream fizzle and die, or as the pioneers who overcame the hardships and paved the way for a better world. We—even we here [that means you, too]—hold the power and will bear the responsibility.

Steve Perlman

Mountain View, California
2 May 1990

1. Singular Vision

Where there is no vision, the people perish.

—Proverbs 29:18

In this section we begin our excursion to track down an elusive quarry: Apple innovation. Although we haven't seen it around much lately, it's not that it isn't here. It's just that we're not sure what to look for anymore. It's not a thing as much as it is a philosophy, a doctrine as old as Apple, yet as fresh as our latest idea. It doesn't lie in the open shouting out to you; it hides from the light of attention, lurking in the hidden corners of our labs. Its devotees are a brilliant, compulsive, peculiar folk who work odd hours and into the night. After years of neglect and abuse its lifeforce is weak, and it has become rare indeed. We hereby embark on a journey to track down this strange and wonderful beast, to lure it out into the open, and then nurture back to its former strength: A Quest for Innovation.

Our first step is a definition of innovation at Apple. Clearly we are not concerned with innovation of the scientific breakthrough sort—inventing the transistor or curing the common cold—but rather innovation of a practical sort— introducing amazing computer technology that is great to use and inexpensive. Thus, our working definition for innovation at Apple will be to achieve amazing technology, great user experience, and low cost, each relative to the context of the product (e.g. low cost in a high-end product is pricey in a low-end product). Ideally, when Apple introduces a new product, we meet all three criteria and have an innovative product (e.g. Mac Plus, Mac II, HyperCard). When one or more of these criteria are missing, we either have an evolutionary product (e.g. the Mac IIx —neither the technology nor price is earth-shattering) or a problem product (e.g. the ImageWriter LQ—the experience is less than great). This definition is hardly perfect, but if Apple's products were limited to amazing technology that provides a great user experience at a low cost, Apple would be in pretty good shape. This definition will serve the purposes of our quest.

Our next step is a definition of Vision: Vision is the foil against which innovation is played. The vision of a product paints a picture of the desired outcome: a range of capability, a nature of experience, a degree of cost. To the innovator, the vision defines the parameters of the problem, the rules to the puzzle. So long as the vision is not compromised, any trick to cost-reduce or performance-increase (in the vernacular, "hack") the technology that implements the vision (within engineering standards) is fair play. Indeed, the cleverer the hacks, the bigger the win, and if you exceed the "amazing" threshold (you know it when you're there) and you're still within the functionality, experience, and cost parameters of the vision, you've got innovation. Vision is an essential prerequisite to innovation. Without vision all you've got are some neat hacks floundering in a sea of incoherence.

Vision flies at many levels. There is the corporate vision which defines a long term direction (like Knowledge Navigator). There is the product family vision which defines the architecture for a line of products (like the Mac). There is the product vision for a particular product family incarnation (like the Mac IIcx). And, there is a vision for a product family functional area (like multimedia). In principle, each subordinate vision is subject to the overall view contemplated by its superior vision. For example, we'd expect the Mac IIcx vision to fit within the framework of the Mac family vision. In practice, however, making such an evaluation requires a clear definition of each vision in the hierarchy, which rarely is available (we'll get back to this problem later). Nonetheless, at every level innovation is dependent on a clearly defined vision.

Curiously, we find that the most important facet of vision is not its correctness, but is rather its singularity. First of all, the notion of a vision that is "correct", or even optimal, is chimerical. The nature of the problems we deal with are such that there are too many parameters to tweak, too many knobs to turn. The best you can hope for is a level of correctness to a vision that brings you within sight of something better so that you know where to go on the next round. For example, the Mac 128K vision was flawed in not allowing for RAM or hard disk expansion, but it was good enough to lead to the Mac Plus vision which fixed those problems. Secondly, no matter how correct any individual vision may be, if no single, common vision is embraced by everyone developing a product, then it is not possible that the various parts will work together elegantly. For example, there are several visions for Mac II RGB output—some with weird connectors, some with monitor sensing, others limited to certain monitors—leading to a plethora of cables, cards, and adapters which we are now only starting to address with our new video cards. And thirdly, we often delay getting *some* solution out the door while we quibble over which of several visions is more correct, when really any of them would probably be sufficient. For example, the sound wars have been raging since the Mac II shipped, and consequently there hasn't been as yet any improvement on the original Apple sound chip, even though several of the proposals have been exciting. Thus, it's not the correctness of *the* perfect vision, but rather the singularity of *some* excellent vision that is essential.

To summarize the first stage of our quest: 1) Our working definition of innovation at Apple is achieving amazing technology, great user experience, and low cost. 2) Vision is an essential prerequisite to innovation, that defines the parameters of the problem. 3) Vision exists at many levels from corporate vision to subsystem vision. 4) The most important aspect of vision is singularity; a single, compelling vision that everyone follows is essential. 5) The objectively "correct" vision does not exist.

Clearly, the innovation process starts with vision. Unfortunately, vision only grows with careful cultivation. The next section is a journey to where this process occurs—under the auspices of Apple's leaders.

2. Leadership of Focus

There go my people. I must find out where they are going so I can lead them.

—Alexandre Ledru-Rollin (1807-1874)

Not to decide is to decide.

—Harvey Cox

The next stop on our quest is a brief visit with an old ghost whose visage has all but faded from the face of the Apple organization: Steve Jobs. When Steve left Apple, I was only just finding my way around the place, so the following is largely based on what I've learned about Steve through people who worked closely with him. Steve's style of leadership, taken in its entirety, just wouldn't work in a company as large and diverse as today's Apple (he is probably best off in a company the size of NeXT), but there are parts to his style essential to innovation that we have never quite recreated since his departure. What I hope to capture here are those aspects of his leadership that supported innovation at Apple, yet manage to excise those aspects of his character which proved to have a less positive effect on the company.

While that passionate, eloquent, inspiring, and unnerving person named Steve Jobs was still at Apple, it was easy to identify him as the person who articulated the vision for Apple products. Whether that vision was correct, objective, or even rational (which it often wasn't), comes as less of an issue than whether the vision was singular, compelling, and decisive (which it often was). Steve's leadership, while in many ways brutal, egotistical, and single-minded, was *leadership in pursuit of a vision*, and despite the fact he sometimes chose the wrong path to follow, we cannot fault him for failing to decide on some path at least. His charisma, determination, and commitment had a profound influence; people were driven (sometimes off cliffs, but driven, nonetheless) in pursuit of one vision. And, often enough the vision he drove to realization was revolutionary and, as advertised, insanely great.

Although Steve was great at articulating a vision and motivating people to follow it, he was not especially gifted at generating the ideas which were the substance of the vision. Those ideas were generated by creative talent within and outside of Apple as a scattered set of laboratory propositions and experiments, just as they are today. Steve's talent was to gather those ideas like a parabolic dish antenna and focus them back in an intense beam of clearly defined vision to the development teams who then worked magic to bring them to realization. Once again, it wasn't that the vision beamed back was necessarily correct or complete; it was that it was just one *singular*, *compelling*, and *decisive* distillation of the stuff coming in.

Steve was always fully committed to some assembly of ideas which made up his vision; if you introduced a great new idea, he'd let you know it was worthless (because he was unwilling to waver on his current vision), then he'd think on it and if he'd decide that your idea was right (not better or worse—right or wrong), he'd let everyone know the old idea was worthless and he'd re-articulate his vision fully committed to the new idea. So, although Steve's vision would change periodically (and suddenly), at any given moment it was stable and clear—everyone watched the same, clear channel tuned in by Steve's dish antenna, even though he would switch channels from time to time.

Steve left behind a bitter taste in Apple's mouth because of some ways in which he was a very demoralizing leader, and I speculate that one of the reasons we have avoided emulating the positive characteristics of his leadership is out of fear of resurrecting the negative ones. I submit, however, that we are really hurting for those positive traits in Apple Products. We need leaders who function as parabolic dish antennae, focusing the wonderful research that is happening inside and outside Apple today into a coherent vision. We need a unwavering, courageous vision beamed back to us which is singular, compelling, and decisive. We need charismatic, committed, and determined leadership to drive the vision home. We need to bring back the good side of this old ghost. And, I believe this can be accomplished without fear of the other side of Steve Jobs. So, we bid Steve's spirit a fond (?) farewell and address a few other issues of leadership which have come up since his departure from Apple.

Now that R&D is a huge organization with several separate divisions, we often find that vision does not follow the same hierarchy as Apple Products' organizational chart. I believe a leader must have the wherewithal to transcend the corporate hierarchy as needed to guarantee the implementation of a vision, especially one affecting diverse segments of R&D. For example, simply declaring that multimedia is a vision for the Mac to the heads of the various Apple Product divisions is insufficient. In particular, after a year or two of disjointed developments it should be clear that the organization, for whatever reason, is not making the multimedia vision happen. At this point, it isn't a matter of re-emphasizing the issue at high-level staff meetings and expecting the folks below to work it out, it is a matter of finding the key players wherever they lie in the hierarchy, going to them directly, identifying the obstacles in the organization, and then *fixing* the problem through clear directives to each of the managers involved. Yes, having a senior executive cut cross organizational borders will ruffle some feathers. But, when the org chart gets in the way of a fundamental vision, it must be bypassed in order to make things happen.

Since Steve's departure I know of very few examples where a leader has transcended the corporate hierarchy to guarantee the implementation of a vision. One such time was in late 1985 when R&D was deadlocked over whether we should go with NuBus or VMEBus for the Mac II slots. There were very good arguments for going with each bus over the other, and both busses provided comparably excellent performance. Since either bus would have been a good choice, we probably would have quibbled over it for another

two months, further delaying the Mac II. Instead, Jean-Louis stepped in, considered both arguments, and declared that the bus would be NuBus. Neither the NuBus nor the VMEBus vision was "correct", but both were excellent. Yet, with two separate visions, neither vision was useful. Jean-Louis' intervention made the NuBus vision the singular, common vision, and that was all we needed. In this case, he could have decided on VMEBus, and the Mac II would have still been a great machine. Sometimes an executive decision is no more than just deciding, but that takes courage, too.

There is one other example of transcending the corporate hierarchy that is worthy of note. This intervention made it possible for Apple to ship what I consider to be our most recent revolutionary innovation, HyperCard. I don't know the details of what obstacles faced HyperCard, but I do know that John Sculley stepped in and overrode those obstacles to see that it was bundled with every Mac. The corporate hierarchy was not structured to comprehend a maverick vision like HyperCard—management's concerns focused on HyperCard's implementation violations (black-and-white, card size, user interface), bundling cost, and HyperTalk support. It took John's point of view from above the corporation to realize that its implementation was tailored to its vision and that the potential cost was worth the potential benefit. Point of view is worth lots of IQ points (thanks, Alan); sometimes a leader's perspective affords a clearer view through a murky decision space. I feel it is essential that leaders take the initiative and act on this perspective, no matter how unpopular those actions seem at the time.

Finally, I believe leaders *must* be respected by their people. No matter how qualified they are for their positions, leaders who are not respected, *cannot* be effective. Respect involves demonstrating noble virtues like courage, integrity, fairness, and vision as well as showing competence. Perhaps leaders should have their superiors periodically visit, incognito, to their communication meetings. Do the people listen? Are they inspired? Do their conversations belie respect? Respect by the people below (not just by the senior managers above) is a necessary condition for successful leadership, especially in a high-performance environment like Apple R&D.

To summarize the second stage of our quest: 1) Leaders function as parabolic dish antennae, beaming back to R&D a focused vision distilled from ideas and results from within and outside of Apple. 2) While the vision may change with the discovery of better ideas, at any given time it must be an unwaveringly singular, compelling, and decisive. 3) A leader must have the wherewithal to transcend the corporate hierarchy when necessary to guarantee the implementation of a vision. 4) Leaders must be respected by their people, not just their superiors, to be effective.

Once we have strong leadership beaming back to us a singular vision, the rules to the puzzle are known, and there is the opportunity for innovation. Generally, however, innovation doesn't come for free. The next section is a journey to where we pay that cost: the Land of Compromise.

3. Compromise without Compromise

We would accept no compromises when we designed the Mac.

—Bill Atkinson, at AUC '89

There is no way we could get a product with the compromises of LocalTalk through Apple R&D today.

—Gurshuran Sidhu, JLG staff meeting, 4/89

With their no-compromise strategy [on the Mac Portable], they created an Edsel.

—Vern Raburn, Symantec CEO, quoted in Bus. Week, *3/19/90*

Our quest takes us next to explore the dark reaches of innovation's inner sanctum. Here we find a face of innovation that has recently fallen from favor, but that we nonetheless must recognize as an important, and indeed essential, aspect of its character: compromise.

Compromise comes in two forms: vision compromise and technology compromise. In each case we use a different meaning of the word "compromise". For vision compromise, we use "compromise" to mean "undesirable concession" as in "a compromise of one's integrity". Vision compromise occurs when a product's implementation does not realize the potential of its vision. For example, a K-12 computer which ends up costing $2500 has compromised its vision of being low cost. Vision compromise is always bad news.

For technology compromise we use "compromise" to mean "solution arrived at by trade-offs", as in "agreeing on a compromise". Technology compromise occurs when a product is implemented with pared down or simplified technology so as to reduce cost or improve performance. For example, LocalTalk provides a vastly cost-reduced local area networking capability by ingeniously simplifying the hardware and utilizing the intelligence of the host CPU, making trade-offs in both hardware and software technology. Technology compromise is always good news until it compromises vision. Vision issues usually arise when we try to make compatible future products since technology compromise often implies less generality (LocalTalk was a nightmare for A/UX). However, we have been getting better at hiding the details of the technology compromise through software abstraction, so the compatibility impact is small (an A/UX-friendly I/O processor is LocalTalk software-compatible). Historically, the advantage gained by having an incredible price/performance ratio for a stretch of time ahead of the competition has almost always justified the impact on future systems (LocalTalk is the most installed network in the world). Indeed, it may be said this principle of technology compromise without vision com-

promise is the cornerstone of Apple's success. That is because this principle—better yet, this art—is also called Apple Innovation.

Technology Compromise without Vision Compromise = Apple Innovation is the best formulation I've found that comprehends the sort of innovation that we do: making trade-offs like crazy in the technology, but without concessions to the vision. You can see how it works: The vision defines some great ideal for a product (like the 1984 vision of a powerful, easy-to-use, affordable personal computer). Using brute-force, no-compromise technology you may end up with something hulking and expensive (like a Xerox Star). But, by making technology compromises that don't limit the scope of the vision, you can create something which is slick and inexpensive (the compromises of a small black-and-white screen, no slots, no hard disk, no RAM expansion, CPU-intensive I/O, heap-based memory management, etc. resulted in a $2500 Mac 128K). So long as the vision is not compromised, then the technology compromises are okay. And, if what we have achieved is amazing technology, great user experience, and low cost, each relative to the context of the product, then what we have is innovation.

Technology compromise for the sake of vision, i.e. innovation, is Apple's legacy. While the Apple II color graphics system was lower cost than its black-and-white competitors, the hack which made it possible resulted in a graphics architecture which was, shall we say, Baroque. While LocalTalk has succeeded in becoming the most widely installed network in the world, its operation continues to hog more CPU cycles than any other network in the world. And, while HyperCard has defined a brilliant new class of Mac application, it also has proudly violated Mac user interface and programming guidelines to achieve this vision. All of these innovations achieved greatness in their day by somehow limiting the generality of the technology for the sake of cost or performance. Although it sounds a little ugly, this is the nature of Apple innovation, and properly controlled through appropriate abstractions (the Apple II graphics system *was not*, but LocalTalk and HyperCard *were*), we can ride the tide of these innovations well into the future. Technology compromise *always* involves hard decisions, but when made carefully and deliberately, these are the decisions that make history.

Unfortunately, to a large degree we have forgotten what it takes to make these hard decisions about compromise. When we used to talk about accepting "no compromise" in our products, we meant no compromise to our vision. Thus, we were driven to make hard technology choices by the requirements of our vision. Today, "no compromise" means no technology compromise, often at the expense of our vision. One would think that portability should have been an inviolable aspect of the Mac Portable vision, but it wasn't—the machine weighs as much as a Mac SE. This isn't surprising because in order to achieve a "no-compromise Mac" not one Mac SE technology was compromised in the Portable. This wasn't the fault of the Mac Portable team. It was Apple's fault—to let the vision of the Mac be reduced to a technology definition, a compatibility criterion. Every new Mac looks the same because it *has* to look the same. Except for refinements to what is already there, we can't touch anything. Without technology com-

promise everything has to be designed in its full generality, at its full cost (and weight). What you end up with is a workstation, not a personal computer. It's no wonder we don't have a viable low end.

In order for us to continue to innovate, we need to be allowed to make compromises in technology. If you want video and animation on a $1000 Mac, we must be allowed to design a graphics system which has limited generality. If you want an inexpensive, lightweight portable computer, it must have limited functionality which its desktop cousins do not. If you want inexpensive sound synthesis, the cost of the DSP hardware must be amortized by having it also function, with limitations, as a modem and a graphics processor. If you want multimedia on the Mac, real-time operating system facilities which have finite limitations must be created under the Mac OS . I know the hackles that these proposals raise: What about compatibility? What about writing all of that Mac ROM code? What about architectural uniformity across the Mac line?

The answer to all three questions is quite simple (and quite complex): cultivate a centralized architectural strategy for software *and* hardware for Mac with rich abstractions that comprehend new application areas (e.g. multimedia, portability). Architectural uniformity, compatibility, as well as justification for writing ROM code comes from everyone working from the same abstraction, the same vision (remember the Mac II development?). Not just a software vision (as compelling as is System 7, it is basically designed for existing hardware), but a hardware vision as well (and not just *faster* hardware, qualitatively *better* hardware). Don't forget that the big advantage we have over Big Blue is that we control the software as well as the hardware. For us to utilize this advantage we need to evolve both ends of the spectrum together. The only way that can happen is with a powerful, common vision wielded with authority by inspired leaders. Instead, what we have today, generally speaking, is a loose confederation of separate divisions, each pursuing independent, albeit related, goals. The gift that has been left us by the architects of Macintosh is a wonderfully interplayed medley of hardware, software, and peripherals. It would be tragic if we were to allow the Mac architecture to evolve into a confederation as segmented as our corporate organization.

An even more daunting implication of a confederation without a common vision is the fate of our future non-Mac CPUs. Some of the smaller projects are probably relatively self-contained, but the major projects rely heavily on system software and peripherals which are in entirely different organizations. Once again, who is defining the overall vision? Who has the authority to direct the vision? The danger we face is that the software and peripheral vision shall evolve independently from the hardware vision, everything will have to be designed in its full generality because it will be unclear which technology compromises are safe, and we will effectively force ourselves into a workstation cost structure (indeed, we are seeing this happen with Mac). The Apple II, Lisa, and Mac all derived their power from a commitment to tightly interwoven hardware, software, and peripherals replete with technology compromise. It is hard to imagine a successful new CPU for which the same is not true.

To summarize the third stage of our quest: 1) Compromise comes in two forms: Vision compromise when a product's implementation does not realize the potential of its vision, and technology compromise when a product is implemented using pared down or simplified technology so as to reduce cost or improve performance. 2) Technology Compromise without Vision Compromise = Apple Innovation: making trade-offs like crazy in the technology, but no concessions to the vision is Apple's legacy. 3) Today, "no compromise" has come to mean no technology compromise, often at the expense of vision. This leaves little room for innovation. 4) We need to cultivate a centralized architectural strategy with rich abstractions that comprehend new application areas (e.g. multimedia, portability, low cost). With a centralized strategy diverse R&D divisions can know what technology compromises make sense in the overall vision, and innovation will be possible.

Thus far on our quest, we have found vision and leadership, and we have crossed through the treacherous Land of Compromise, learning about the cost of innovation. These organizational aspects of the quest lie behind us, but we still have not found innovation. This is because innovation does not just arise out of the Apple organization, it comes from Apple people, Apple innovators. The remaining sections are about Apple innovators and the obstacles that they face.

4. Passion to Create

> *When I am ... completely by myself, entirely alone ... or during the night when I cannot sleep, it is on such occasions that my ideas flow best and most abundantly. Whence and how these come I know not nor can I force them ... Nor do I hear in my imagination the parts successively, but I hear them* gleich alles zusammen *(at the same time all together).*
>
> *—Wolfgang Amadeus Mozart*

Finally, our quest takes us to the heart of the innovation at Apple, to the place where the seed of vision sprouts, inexplicably, into a radiant flower of new invention. To the place where a mere assemblage of raw technology takes shape as a work of art. To the place where the dreams of the future materialize into an exposition of the present. This place is not a building or a room or a desk. It is a private, personal space that others may not enter and may only gain a view indirectly through the creations shaped into tangible experience by the mouth and the hands. This space, and this the most precious asset of the company, is the mind and spirit of the Apple Innovator.

Innovation is a product of the mind and spirit. Although this might sound obvious, it is essential to appreciate that innovation is not an workaday product which has a known, repeatable process for its creation. You cannot write a contract for innovation; you find people who have shown potential for innovation, put them in an enriched environment of vision and opportunity, and let them do their thing.

Just who these innovators are and just how they accomplish their innovation is as varied as there are people. I've seen women and men of every shape, size, and color. Some innovators like to work in dead quiet, while others like blasting rock 'n roll. Some get their greatest insights tossing fitfully in bed, while others find their inspiration relaxing in a hot shower. One confessed that supreme clarity of thought occurred only after terrific sex. Some work best alone, some best in teams, some best at home, some best in the office. Some live on pizza and beer, others are health food nuts. There is no "typical" innovator, so trying to formulate an environment which would be best for everyone is just not possible.

However, there are certain common traits that we find among intensely creative individuals which can help us understand their motivations and accommodate (within reason) their needs. Innovators have a passion for finding clever solutions to apparently inscrutable problems. They derive a great deal of satisfaction, first and foremost, from the solutions themselves, and secondly, from people admiring the solutions. But, to say that innovators work at a problem until they find a solution is not quite accurate. It is more correct to say they *engage* a problem, tirelessly wrestling it to the ground until it *surrenders* a solution—the element of

concentration is not unlike that of an artist; innovators are *driven* to create. The act of innovative creation is a complete commitment of mind and spirit, an all-consuming passion.

Innovative solutions frequently require a completely novel point of view. To get to that point of view involves turning the problem over again and again until that point of view is found. In fact, it may require the synthesis on an entirely new language or notation in order to work within its space. The mental gymnastics involved in making these transitions can be described as nothing less than an agony of creation. Innovators don't subject themselves to such an ordeal for money or power. They do it because they are driven, committed, and obsessed with reaching that solution. The energy to innovate is there. The challenge for Apple is harnessing that energy by keeping innovators inspired.

Uninspired innovators are worse than useless. Inspiration gets replaced by negative feelings such as lost trust in leadership, disillusionment with vision, or feelings of self-doubt. Often an innovator's mind latches onto these emotional problems with the ruthless ferocity of the process of creation and leaves no energy for working on meaningful problems. There is no satisfaction gained from these emotional problems, so it is pure stress without any reward in the end. Imagine the waking hell a host of solutionless emotional problems would be for a person whose mind *must* engage pressing problems by obsessively turning them over and over, up and down until a solution is gained. Regrettably, highly creative people are some of the easiest people to hurt, and a large part of keeping them inspired and focused on meaningful problem-solving is keeping close tabs on what's on their minds and helping them avoid unnecessary conflict.

It is important to understand that just because innovative genius makes innovators geniuses at their art, it does not make them geniuses at everything. Indeed, it is normally the case the focus needed for extreme proficiency in one field tends to limit one's experience and confidence in other aspects of life, particularly interpersonal skills. There is the occasional Renaissance person that comes around, but even these people tend to be less studied than you might expect when it comes to experience and sensitivity in social discourse. The innovators who have created awesomely complex and insightful parts of our latest generation of computers might very well be children when it comes to understanding their own feelings or the feelings of others.

So, running Apple R&D is a little like running a summer camp, only worse since many of the managers are innovators themselves with the same interpersonal limitations. And, it is a camp with the worst kind of kids—restless, disobedient troublemakers. Passion, intensity, drive, and recklessness characterize these children. And, the self-confidence necessary for creating entirely new inventions frequently is fueled by an enormous ego. Enormous egos feel threatened by other enormous egos. And, often the interpersonal skills to comprehend and make sense of the threat are not known to the people involved. Even among the most socially insightful, the depth of concentration that is reached during the process of creation at times will render them numb to human feeling.

One might think from the previous paragraph that Apple R&D is a churning hive of interpersonal conflict. As it turns out, however, conflict is the exception rather than the norm. Apple people, innovators included, are terrific. There is a common purpose to create, and one holds an admiration for one's colleagues and their work. Against all adversity of circumstance, it is the character of Apple people and a commitment to Apple's vision which usually raises them above meaningless conflict. Well, usually, anyway.

Sometimes innovators need help in getting along with each other. Unfortunately, this is where the Apple system is very ill-prepared. Although there are courses for managing interpersonal relationships, there is no course which specifically addresses the needs of intense, creative people like Apple innovators. Moreover, there are no requirements for Apple managers to take any of the courses that are available. And, when the manager is one of the people involved in the conflict, there is no mechanism whereby an outside counselor specifically trained to handle this sort of conflict can intervene. HR laisons try to fill this role, but since our HR laisons also have large administrative responsibilities which specifically support the manager, it is hard for them to also represent the innovator, and the conflict resolution can be extremely one-sided. Moreover, HR laisons are swamped. They don't have the time to function effectively as counselors. I have seen brilliant, valuable, and good-hearted innovators subjected to rank humiliation by their innovator cum manager with HR looking on with little more to offer than a recommendation for the innovator to seek therapy. One would think that HR laisons function as watchdogs of Apple Values, but in my opinion they function primarily as the agents of management.

I really wish we had a department of counselors whose sole function was to ensure that all parties are heard, recognized, acknowledged, and critiqued, openly and directly. Managers, like everyone else, sometimes feel threatened or insecure and need someone to curtail their rash actions, especially if they became professional managers via being professional innovators. There have been too many terrible and wasteful conflicts, even tragic losses of close friendship, than Apple can afford. In most cases the people cool down, and they wish that some things hadn't been said, but by that point everyone's ego is so damn entrenched there is no positive solution space and everyone loses. We need better mechanisms to deal with the specific interpersonal issues that arise from innovators working together.

Like all people, innovators respond to recognition and incentives, but unfortunately Apple has a very spotty track record for acknowledging innovation. For example, the quintessential recognition for innovation is the patent award. It is something which, by definition, is only granted to innovators. It is a relatively small, but extremely meaningful, bonus check which is given when patents are filed and granted. It really isn't the check that matters; it is the handshake and maybe a congratulatory memo that accompanies it, but to not give any recognition is just shameful. Last year after no patent awards had been given for almost 2 years, I personally sponsored a make-your-own-sundae party for inventors so as to bring atten-

tion to the problem. This led (several months later) to a patent award party and recognition of invention at a communication meeting, and supposedly the institution of a regular system of patent recognition. Just last month I received a check in a unmarked envelope for an unspecified bonus. I called to find out what it was for, and I was told it might be for a patent. Which patent? Several weeks later, I was told it might be for a tiltable screen patent. When I pointed out that this was not my invention, a week later I was told the check probably was for one of the patents I filed in 1986. I'm still not certain what the check in the unmarked envelope was for. No bonus should ever be delivered in an unmarked envelope; a check has no meaning without an attribution and a handshake. Considering my efforts at bringing attention to the patent award problem, the type of "recognition" was completely demoralizing.

We need a more equitable bonus system. First of all, according to the HR handbook senior people are basically guaranteed huge bonuses while junior people have to really hustle to qualify for relatively small bonuses. There is a conceivable argument as to why senior people should get larger bonuses, but why should they get them virtually automatically? How can that provide incentive to achieve? Also, (this is not in the HR handbook, but I found out the hard way) it is incredibly difficult to give someone a bonus who is not in your same division. Part of the process of innovation is people from all segments of the company working together and helping each other solve problems. Sometimes that work is extraordinary and deserves a bonus. This should not involve a fight over whose budget it comes from and whether it interferes with the person's bonus ceiling for the year. There should be mechanisms to handle this sort of occurrence, or we are effectively encouraging the stratification of the organization.

Finally, one more observation: innovation is fundamentally incompatible with politics, and innovators cannot operate in a politically-charged environment. That is to say, it is not possible to politically engineer innovation; while politics can influence management and subject people to arbitrary decisions, it cannot instill innovators with inspiration and vision. Indeed, in my experience politically active managers have engendered little empathy among innovators except a sense of fear and distrust. Some background politicking is an unavoidable aspect of every human organization, but we must realize that in visible doses it kills innovation. It saps the spirit of the innovator with the concern of intangible decisions beyond any rational control, it works against already strained teambuilding efforts between groups, and it makes radical proposals too easy to kill (see the section on the Salieri Syndrome, below). Politics has no place in Apple R&D.

To summarize the fourth stage of our quest: 1) Innovation is a complete commitment of mind and spirit, an all-consuming passion. 2) Innovators are not geniuses at everything; often they are limited in interpersonal skills. 3) Apple needs better mechanisms to deal with conflict between highly creative people. 4) Apple's incentive plan for patent awards and bonuses is often demoralizing. 5) Innovators cannot function in a politically-charged environment.

Now that we have met the innovator and have taken a peek at the creative process, we will now make a brief visit to the pinnacle of Apple innovation: the Apple Fellows.

5. Fellow Citizens

There is only one proved method of assisting the advancement of ... science—that of picking [women and] men of genius, backing them heavily, and leaving them to direct themselves.

—James Bryant Conant

No quest in pursuit of innovation would be complete without a brief visit to our quintessential innovators, the Apple Fellows. To my knowledge, there have been six Apple Fellows. Two have left Apple. One, Steve Wozniak, at this point effectively holds an honorary office. And three, Bill Atkinson, Al Alcorn, and Alan Kay are currently active.

Apple Fellow is the highest rung in the individual contributor ladder, the CEO of innovation. But, Fellow is specifically not a management position, so there is little administrative overhead attendant with the seniority. Apple Fellows are allowed to pursue their own research directions (I suppose within budgetary reason) in the hope that they will come up with new inventions, new creations, or new insight. HyperCard is perhaps the most recently visible product of an Apple Fellow, but less visible research, including the Big Mac under Rich Page (currently at NeXT) and the Vivarium project under Alan Kay have had a substantial positive effect on the development efforts in Apple R&D.

Apple Fellows also serve as an inspiration for aspiring innovators. Even before young innovators join the company they know of the legendary accomplishments of Bill Atkinson and Alan Kay. If they've got talent and if they put their hearts and their souls into their work, they know that someday they might, just might, qualify for the position themselves. It could be the case that the value of the Apple Fellows program as an inspiration to innovation is greater than the output of the Apple Fellows themselves.

There is, however, a scratch or two tarnishing the image of the Apple Fellows. The most visible problem is that lately Apple R&D has been unable to produce talented scientists that qualify as new Apple Fellows. We have not seen an appointment in about four years, and we haven't seen an appointment from within Apple in about seven years (more than half the age of the company!). Indeed, of the three active Fellows, there is only one, Bill, who earned his title working at Apple. I am no advocate of watering down the quality of the people who we appoint to this position, but after seven years there must be one or two brilliant people from within Apple who have made substantial, consistent contributions to innovation who would be an asset to the title. While it is incredibly valuable to find great people from the outside and make them Apple Fellows, we also need to honor our own innovators once in a while.

And, one final comment is that I think Apple should consider appointing guest researchers temporarily to the position of Fellow. We are big

enough to support one or two research programs which may not be directly tied to internal Apple efforts, and the presence of esteemed researchers would have a positive influence on Apple R&D. A few years ago we were honored with the presence of Ivan Sutherland and Bob Sproull, both pioneers in computer graphics, temporarily conducting research in ATG. While Apple benefitted an enormous amount from their project work, the people of ATG also benefitted an enormous amount from their perspective, inspiration, and ideas. They really were like temporary Apple Fellows. Perhaps we could invite other esteemed scientists as visiting Apple Fellows in the future.

To summarize the sixth stage of our quest: 1) The original work of Apple Fellows has had a great technical and inspirational impact on R&D. 2) Only one of the three active Fellows is home-grown from Apple, and he was appointed seven years ago. Appointment of a deserving person from within Apple would be an asset to the program. 3) Apple should consider appointing guest researchers temporarily to the position of Fellow.

Now that we have visited with the most visible innovators of the Apple community, our quest takes us to visit with a group of people that so far have been allowed only a small role in the process of innovation: women engineers.

6. Smart Women

It's not just clever; it's ingenious.

—Sally Ride after a demo by an Apple woman engineer, 1/90

A man of sense only trifles with them [women], plays with them, humors and flatters them, as he does with a sprightly and forward child; but he neither consults them about, nor trusts them with, serious matters.

—Lord Chesterfield (1694-1773)

When I grow up, I want to be a scientist ... and a ballerina.

—confessions of a four-year-old, 11/89

This next stop in our quest drops in on some colleagues who are trying, really trying, to become fully accredited members of the Apple R&D community. The obstacles they face at Apple are similar to the obstacles they have faced all their lives, and while we'd all like to believe those obstacles couldn't exist at a progressive company like Apple, close inspection reveals that they do. Centuries from now, when posterity looks back on the impact that this century has had on the human race, it certainly will note the explosion of great technologies including our favorite technology, the computer. But, all of these innovations will pale in comparison to the most profound change to human social order since the formation of permanent settlements: the enfranchisement of women as full partners with men. This section is about our small part in this great social upheaval: women engineers in Apple R&D.

There are no women in senior R&D management. There are almost no women in management positions which supervise advanced project teams. There are almost no women who have filed patents. There are no women Apple Fellows. Indeed, there aren't many women in technical positions at all, and generally speaking the positions they hold are not ones which involve key development responsibility. It is fair to say that, with some notable exceptions, woman hold no power in Apple R&D and Apple innovation is the exclusive province of men. The above 200-year-old quote by Lord Chesterfield is still a reflection of the situation at Apple today.

Clearly, nobody advocates a situation where women do not participate in an activity at the heart of Apple. And, clearly nobody is deliberately placing obstacles in their path. As might be expected, the reasons are rather subtle, and sneak up on people with even the most progressive intentions. To understand these subtleties we must first review the major characteristics which distinguish women engineers from their male counterparts.

Women engineers tend to be slightly shorter and of smaller build than the men. Their voices are of a somewhat higher pitch and sometimes they wear skirts. And that's about as much of a generalization as can be made because the similarities between men and women engineers are vastly more significant than the differences. Given intriguing problems, women engineers are obsessive in problem solving; given inspiring vision, they become deeply committed to realizing that vision; and given the chance, they are insightful in coming up with clever inventions. I have had the privilege to work with women who were certifiable geniuses and with some who were just talented engineers. I have learned from some with great experience, and I have taught others with less experience. I have seen some meet with success in their endeavors, and I have seen others find failure. I can make the exact same remarks about the men engineers with whom I've had the privilege to work. The differences between individual engineers is far more significant than the differences between men and women engineers as two groups.

If it is not outward differences that are getting in the way, then we have to look deeper, within ourselves, to understand the source of the obstacles. One place we find an obstacle is within what actually is on the surface very positive, even loving, behavior: fatherly guidance. In the course of my career I have been fortunate enough to have had a few managers and execs take me under their wings and share with me some advice and insight that they have acquired over the years. There is no doubt that they saw a little of themselves in me (like father to son), and I expect that at some point early in their careers some men had given them similar mentorship. They have watched me grow, they have given me chances to prove my mettle, and when I have failed, they have helped me understand why.

Is there fatherly guidance for women engineers as well? In fact there is, but it takes a slightly different form, and I think this is one source of the problem. Engineering managers (who are virtually all men) often see themselves in young women engineers in a similar way as a father traditionally sees himself in his daughter. The behavior may still be one of loving guidance and support, but it often reflects more of a sense of providing protection from failure with gradually more difficult tasks than of providing challenges to let her prove her mettle under fire. For example, an engineer was needed to take technical lead of a small team on the critical path of a key project. A woman engineer who had turned out consistently excellent work on earlier projects expressed a strong interest in leading the team, but was passed over in favor of a man of less experience who had expressed ambivalence towards the leadership role. Instead, the woman's manager gave her a well-defined set of tasks under his supervision where she could grow out of the line of fire. I wonder if rather than challenging someone who was looking for a challenge, her manager's concern was protecting her from potential failure.

The typical task given to a women engineer is a directed, well-supervised activity with a man engineer nearby as teamleader. Although this protects a woman from direct responsibility for failure, it also is a guarantee that the woman won't learn the hard lessons that can only be learned on

the front lines. While the men are learning about leadership and situations that lead to failure, the women are learning how to be staff engineers to support teamleaders. We are falling into the traditional male-female hierarchy.

The only way I can see Apple getting beyond this model is by making an effort to have managers empathize with women engineers as "sons" not daughters. When a manager stops trying to imagine how a young woman would feel in a certain situation, and starts thinking about how he felt when he was at the same point in his career, then he can help her grow into a leadership role, if that is where her destiny lies. Yes, sometimes she will fail, and yes, she will learn from those failures, just as he did from his. And, someday perhaps she will find a little of herself in some young engineer and help her or him to grow as well.

I have offered above only a few (tame) examples distilled from my experiences and the experiences women and men have shared with me. There are many other stories to tell, and some of them are really scary. We have to recognize that understanding how men and women work together in a traditionally male-only field is an ongoing task that requires creativity and constant re-evaluation. So, much like our innovative efforts with technology, we must establish a vision, make our best efforts to reach that vision, and when we fail, we must pick up the pieces and try again. It takes courage and determination, but history mandates our success. Indeed, if we're looking for a secret economic weapon to compete with Japan, the power of women in the American workforce may well be it.

To summarize the fifth stage of our quest: 1) The similarities between men and women engineers far outweigh the differences. 2) Managers (who are almost all men) providing fatherly guidance often treat young men engineers like sons and young women engineers like daughters; while the men are given challenges to test their mettle, the women are protected from failure by being given progressive tasks. 3) Women need to be treated like "sons" to have opportunities to realize their potential. 4) Understanding how women and men work together is an ongoing task.

Finally, we move on to the last stage of our quest. Now that we have explored the process of innovation and the people who are innovators, it is time to drop in on our old nemesis, the enemy of innovation from time immemorial. This last stop is an extremely important one, because of all the obstacles which exist to innovation, this is the only one which deliberately sets out to destroy it. It is the ghost of Salieri, the Patron Saint of Mediocrity.

7. The Salieri Syndrome

From now on we are enemies, you [God] and I, because you choose for your instrument a boastful, lustful, smutty, infantile child, and give me for reward only the ability to recognize the incarnation. Because you are unjust ... I will block you. I swear it. I will hinder and harm your creature on earth as far as I am able. I will ruin your incarnation.

—*Antonio Salieri from Peter Shaffer's* Amadeus

And look upon this moment, savor it, rejoice with great gladness, great *gladness. Remember it always for you are joined by it. You are one under the stars. Remember it well, then, this night, this great victory, so that in the years ahead you can say, "I was there with Arthur, the King!"* FOR IT IS THE DOOM OF MEN THAT THEY FORGET.

—*Merlin from John Boorman's* Excalibur

On this, the last stop of our quest for innovation, we dare to visit with innovation's most dangerous enemy, its self-proclaimed nemesis, Antonio Salieri. In real life Antonio Salieri was a composer who lived in Vienna at the same time as Wolfgang Amadeus Mozart. In the play and film, *Amadeus,* the playwright Peter Shaffer tells an account of Mozart's life in Vienna with Salieri as a mediocre composer who ultimately destroys Mozart out of jealousy for his genius. What transpires in the story is a timeless re-enactment of the sort of problem we sometimes run into when we have passionate, inspired, up-and-coming innovators work under the auspices of staid, average, established engineers. If you haven't seen the movie, you should because it tells a story which is played out at Apple every day.

The story goes like this: Salieri has a gift for appreciating the beauty of music. His life's aspiration is to become a great composer, and through prayers and hard work he eventually attains the rank of court composer for the Emperor in Vienna, which was then the music capital of Europe. Salieri is successful, well-liked, and his music is lauded for its greatness; his life's dream is realized. Then Mozart shows up. Mozart is a conceited, obnoxious, spoiled, playful, passionate, delightful, horrible little monster whose inspired genius makes Salieri's greatest accomplishments seem amateurish by comparison. Although the Emperor likes Mozart's music, it is only Salieri who is gifted enough to appreciate the true genius of Mozart's creations, and it drives Salieri into a rage of jealousy when he finds out that Mozart creates it *all in his mind,* without even a piano or manuscript (see the quote in the Passion to Create section). Salieri resolves to destroy the unsuspecting Mozart by using Mozart's trust in him as a fellow musician, by manipulating Mozart's fears and doubts, and by utilizing his political

position as the musical advisor to the Emperor. Mozart was buried in a paupers' grave at the age of 35, and the world was deprived of perhaps half of his potential musical productivity. For this monumental accomplishment, Salieri dubbed himself the Patron Saint of Mediocrity.

Although the story takes place hundreds of years ago, the parallels to situations that regularly arise at Apple are striking. This isn't a new problem at Apple, but as we have gotten larger and senior decision-makers increasingly have been relying on second-hand and third-hand information, there are many more opportunities for a Salieri to manipulate management with disinformation about innovators. It is very hard for people making decisions far removed from the actual development work to distinguish between a conscientious individual prudently managing risk and a Salieri vindictively blocking the work of an innovator. Let's take a look at the Salieri process in an Apple context, so we can better understand how something so terrible can occur. The following events is an assembly of elements of several Salieri incidents that I have watched unfold (from either the inside or outside) or have heard about from others. Unfortunately, in almost all cases the Salieri wins and the innovative work is destroyed.

Salieris (the plural of Salieri, if you will), like the innovators they prey upon, are of both sexes and come in all shapes, sizes, and colors. I actually have seen them come in all ages, but the young ones (generally) don't have much in the way of political clout, so they usually aren't much of a threat—yet. While they carefully project a stately image of assured confidence in their own accomplishments and altruism in their support of those of others, Salieris are in actuality fundamentally insecure and pathologically jealous. While most of us see the excellent work of a fellow innovator as a benefit to ourselves, at least indirectly through its benefit to Apple, Salieris can only view the success of another as a threat to their own preeminence. And, eliminating that threat (naturally, without risk to themselves) is their overriding motivation.

[For readability, throughout the remainder of this section I shall refer to the hypothetical Salieri using the pronoun, he. But make no mistake: women make fine Salieris as well. Also, I shall refer to the hypothetical innovator who is the object of the Salieri's jealousy using the pronoun, you.]

A Salieri generally starts out by developing your trust. He may have nice things to say to you or perhaps compliments for your work. He chums up to you, maybe offering a little helpful advice, slipping you tidbits of inside information, or arranging for small opportunities, meanwhile always extolling your brilliance and expressing his admiration. He makes it quite clear that for purely altruistic reasons he is anxious to help you: he offers the benefit of his experience, his political savvy, his credibility in advocating your work, and his position of influence. So, you trust him. He fits the pattern of the father figure (mentioned above in the section on Smart Women), and you accept him as a friend. He also makes sure that his actions do not escape the notice of other people around you. By initially establishing himself as your "advocate" in the eyes of others, people are much more likely to take his remarks to heart when he finally makes the move to malign your

character. Very sneakily, he gains your trust and and the trust of others as your representative.

Then, funny things begin to happen. Sometimes it is obvious: perhaps the slides he presents on behalf of your work profess a far greater risk with far less benefit than you had discussed with him—but it's too late to change them in the meeting. Sometimes it is subtle: perhaps he forgot to tell you that six months ago he had reported that your design was almost certainly infeasible, and it had been dropped from next year's budget. And, sometimes you only find out if someone tells you: perhaps he lies to a colleague that holds a petty jealousy against you, and tells her that you had brought her competence into question.

The time when a Salieri makes his boldest and most devastating moves is when you are otherwise under fire: perhaps your project is behind schedule, a problem is uncovered with a key vendor, there's a budget crunch, you're in conflict with a colleague, or maybe you're going through a divorce and can't focus your energies on work. Anytime there is a small spark of negative emotion in others or personal weakness in your own life, a good Salieri will jump in and fan the spark into a blaze. After everything has burned to the ground the players will look around at the ashes wondering how they could have destroyed so much so quickly. And, the Salieri will be conveniently out of sight with another notch in his belt.

Once in a while, however, Salieris don't win. Either they are discovered early enough and their actions exposed to undermine their credibility, or the people involved are convinced to take a personal look at the situation, and realize that the stories they have been told have no basis. In one case at Apple, sabotage was twice unsuccessfully attempted on an innovative project, and finally in a third attempt at sabotage the project was "proved" infeasible by virtue of an analysis by "experts". After essentially begging senior management the team of innovators was allowed one month to design and fabricate two complex gate arrays—an impossible feat. The team took a risk on a brand new quick-turn gate array technology, basically lived in the lab with no sleep for a month, and barely managed to get both chips working the night before the scheduled drop dead date. I will never forget the look on people's faces when a working prototype was rolled into the conference room. Instantly, everyone realized that they had been pawns in a huge political disinformation campaign. So, innovation won in that example, but it was at the cost of an enormous battle to fight off the first two sabotage attempts and a superhuman effort to fend off the third attempt. And, this was just to get management to listen to the music of innovation *just once* over the din of a Salieri's political maneuvers. But, you can't pull a rabbit out of your hat whenever you come under a Salieri's attack (especially a subtle attack). By the time you realize what is happening, everyone has already been briefed with their opinions formed against you. Once the political ball is rolling, there is no stopping it. Even your old friends shamefully step out of its way. And, mediocrity reigns supreme.

We can easily let Apple be taken over by Salieris. They have the effect of leveling off the playing field so that innovators, especially inspired individual mavericks, don't stand out. The end result is a controlled, pre-

dictable environment where innovation is limited to what may occur within the safety of politically-sheltered projects. That's not bad, but it's not a situation that invents and ships another HyperCard. Indeed, most of the large, structured projects now in place had their humble beginnings in maverick research projects that somehow managed to survive.

Stopping Salieris starts with realizing that they exist. The next most important thing is to employ an old-fashioned concept called "trust". Salieris are opportunists; they are parasites that accelerate the demise of an already weakened organism. They work by amplifying the fears, insecurities, and jealousies that arise between people. Merlin's warning to King Arthur and his knights, quoted at the head of this section, applies to the potential doom of the kingdom of Apple as well. Merlin urged Arthur's people to remember a moment of greatness they shared together, to harken back to it when doubt would cross their minds, and to not let future petty rivalries undermine the trust they had forged together with their victory. Unfortunately, as the legend goes, mistrust, doubt, and jealousy, amplified by a "Salieri" named Morgana, tore apart old friendships and alliances, ravaging Arthur's great kingdom with civil war. We mustn't let this happen to the kingdom of Apple. It is simply a matter of trust.

It is very easy to forget that we are all part of a great team all working toward the same goals. It is very easy to forget that the success of others at Apple is our success as well. It is very easy to forget that the innovation of a colleague may be a great platform upon which to build one's own innovation. I wish I could say that you can trust everyone at Apple, but I can't—not anymore. However, a measure of caution does not warrant a dollop of paranoia. Salieris make up a small minority of the Apple community; the vast majority of Apple people are good-hearted, well-intentioned, trustworthy individuals. A person's character and motivations don't change overnight.

When you've worked with a person for a long time and they have proven to be a consistently honorable and reputable person, then trust them. Don't let someone else turn you against them. We all feel a little competitiveness with our colleagues, even with our best friends. Overcome these emotions with reason. Don't let someone else cultivate that competitiveness into jealousy. If someone gives you information that makes you feel negatively about a person you trust, then don't just simmer over the accusation, but go find out if it has substance. *Talk* to people when you feel negatively about them, and realize that there are those who would turn you against them. Salieris cringe in the light of mutual trust and respect. Don't become a pawn in a Salieri's campaign against a colleague.

Remember that Salieris are fundamentally insecure. People who spend more time denigrating other people and other projects than they do pointing out what may be learned from the good work of others may very well be Salieris. *This is the best way to get an early warning of a Salieri.* As with any cancer, early detection of a Salieri greatly improves one's chances of survival. When you find someone who you think may be a Salieri, watch out for actions both against yourself and against others. Don't forget that no one can fight a Salieri alone. If he attacks someone

else, stand up to that person's defense. If he attacks you, then call on your colleagues to stand up to your defense. We have *got* to stand as one when innovation is under attack. It is never just "their problem"; it is our problem as well. And lastly, if a Salieri is exposed, *shun him*. Don't *ever* trust him again.

Each of us can remember a time of great victory when we forged a bond of trust with our colleagues. Maybe it was a breakthrough at 3 AM, a hot product intro, a great demo, a presentation at a conference, or maybe it was just a terrific game of ultimate frisbee. It might even have been the bond we felt together as a company when we watched Randy and Don trounce IBM with their "dueling user-interface" shtick during the Communication Meeting last summer. Apple has one of the finest R&D organizations, some of the finest engineers, and some of the best products in the world. Remember our times of greatness together. Remember how it was our various efforts combined as one that gave us our success. Remember the trust and respect we shared among ourselves. FOR IT IS THE DOOM OF PEOPLE THAT THEY FORGET.

I chose to end this quest for innovation with the Salieri section to underscore just how tenuously Apple holds on to innovation and just how serious are the obstacles that we face. Be aware that these perils exist, but invest your energies on the positive concerns of vision, leadership, and compromise that were discussed in the first sections. If everyone can just focus on those three things and trust in each other, there is no force on this earth that can stop us.

To summarize the seventh stage of our quest: 1) A Salieri is a pathologically jealous person who preys upon innovators and innovation. The name comes from a character in the play and film, *Amadeus*. 2) Salieris operate by cultivating the trust of innovators, then undermining their credibility behind their back. 3) Innovation rarely survives a Salieri's political maneuvering in today's Apple. 4) Salieris cringe in the light of mutual trust and respect. The only way to stop them is to detect them early, and then to all stand as one against them.

As we depart from the lair of Salieri, we check our backs to make sure there are no knives protruding, then come back into the light. If you have gotten this far, your eyes are probably quite sore, but you have hopefully gained some insight into my perspective on what it takes to keep innovation at Apple. If you are interested, I have written a brief section with my specific recommendations for structural changes at Apple which I think might help foster innovation. And then after that, there is an afterword with some personal remarks to my friends at Apple.

8. Recommendations

Architecture begins where engineering ends.

—Walter Gropius

Throughout the quest for innovation I've made some proposals of a general nature that work within the established R&D organization. In this section I introduce some specific ideas which go beyond the current R&D organization, or for that matter, the new organization as it has been contemplated (at least to the best of my knowledge). This section is about growing up without growing old—extending the powerful, compelling, insanely great visions that are our legacy across an organization which extends throughout Silicon Valley and even around the planet. As you might expect, it is about the communication of ideas, but more importantly is about the formulation and sharing of vision.

In the section about Compromise without Compromise I posed the question of who is responsible for specifying the overall vision for, as an example, the Macintosh family. While Steve was still here, it was quite clear that vision was specified by senior management, i.e. Steve himself. Today it is not so clear. Senior management's primary function, as far as I can tell, is a supervisory role for the operational needs of the organization. This includes securing budget, headcount, and office space; supervising the supervisors of ongoing projects; and making overall strategy judgments. Calendars often are solidly booked from 8 AM to 6 PM with a slot for an executive lunch, and occasionally they have to show up for some dinner engagement as well. Where is the time to meet with innovators to distill an overall vision? In practice, there is none.

In the past few years the senior managers (and the middle managers, as well) in Apple R&D have had fairly little formal involvement with the formation of vision. Responsibility for vision has trickled down the hierarchy until it has come to rest in the hands of the project teams. The strategy for the evolution of the Mac family largely has been determined by whichever technologies are selected by the project team making the next-generation Mac. Cross-project decisions only occur because of the good graces of the project teams involved. For example, the fact that there is a different direct slot for virtually every different Mac is a reflection of project-focused vision. Rather than formulate a common, fast expansion slot vision, we left it up to each CPU project to formulate its own. And, the further away the project teams are from each other, the lesser the likelihood that there will be a close cooperation between them. For example, we have known that we would be providing an NTSC video output capability in 1990, but there was no monitor strategy coordinated in peripherals to support it. When NTSC mode is switched in using our new cards, all Mac monitors go black. You need to buy a third-party or IBM monitor to have it work ele-

gantly. Clearly, the powerful integration of technologies which we had accomplished in the original Mac is not possible with project-focused vision.

So, if senior management is too busy with operational responsibilities to provide an overall vision, then who can? The answer is we need another organizational hierarchy, one which follows the hierarchy of vision: a hierarchy of systems architects. The job of specifying the overall vision of the Mac family is more than a full-time job, and I think we should have a person whose job function is exactly that. Naturally, this person will need information about the various subsystems within the Mac, and there should be an architectural representative for each of these subsystems. Also, these architects will need information about market strategies and other issues, so there should be representatives from the various marketing constituencies as well as ones from manufacturing and other relevant units. Together, the head architect and the representatives will be able to formulate a strategy for each aspect of the Mac family, be it mass storage, video, networks, multimedia, etc. Then, each constituency in R&D will know what they must do in order to fit within the overall vision, as well as which other projects they must work with to make sure that there is seamless integration across the family.

Although this may sound like a simple idea, there is a fundamental problem of where we shall find these insightful and inspired architects to formulate our vision. We're in luck: each constituency effectively has its architectural leaders already. Everyone knows who they are; they just don't have a special title for their role. These people shall be appointed from within each constituency as their representatives (for example, the networking folks will choose some network guru), and even the overall architect shall be chosen (by some method or other) from within the R&D organization. This is a similar process to selecting the representatives for the existing Engineering Cross-Functional Review. These people shall now have a formal organization in which to meet and specify product line direction.

We run the danger in this situation of having a vision formed by this large architectural committee which would be just as watered-down as the project-focused visions have been. Consequently, I would recommend that the head architect really functions like a Steve Jobs and *directs* the architectural vision for the family. Naturally, this person's information would be gathered by the various constituency architects, and naturally, this person's vision would be subject to criticism and debate. But, I want to make it possible for an integrated, overall experience to be formulated all at once, so that the *integration* is a work of art as well as each individual subsystem.

Since we will have a formal organization for the specification of vision, we can also have that organization produce a formal set of documentation which defines the architecture and the growth strategy for the Mac family. For example, a multimedia hardware person should be able to look up the plan for mass storage improvements, and if she finds that she needs higher data bandwidth than is in the plan, she can tell her architectural representative to bring it up in the committee. This may result in a discussion in the architectural committee, and the disk drive architects may report that they can provide more bandwidth, but only under certain condi-

tions, which may impact the operating system architects, but maybe the operating system architects can accommodate the disk drive constraints, ... etc. In other words, there will be documentation that everyone in R&D can access (perhaps we can keep it on-line), and when they have ideas for changes, there will be a forum where it will possible to effect these changes, even if it means technology compromises across groups.

Now, a large, formal architectural committee is necessary for a mature family of machines like Macintosh, but for new systems under development, such formalities may be unnecessary. I think that any vision decisions which are relegated to within a single project should be reconciled in whatever way is best for that project team. The team need only have an architectural representative go outside the project to the extent that the project is connected with other projects. For example, a new CPU development which is entirely self-contained can formulate its vision in whatever manner it wishes, but if the project relies on standard Apple peripherals, it must provide a representative to have a voice in peripheral vision decisions.

So, where does our existing management hierarchy fit into this organization? Just where they are today, providing operational supervision and formulating overall strategy—except, they will be operating within the vision provided by the architectural organization. Naturally, they will have a big say in the visions when they are formulated, just as they do now with the project-focused visions, but they will not have the role of actually formulating the visions. The formulation of vision is a full-time job, and they just don't have the time to do it well.

If we can create a strong, respected architectural organization, we can really harness the power of all the distributed talent in R&D as well as leverage off the clout of the Apple corporation. We will be broadcasting to R&D a singular, compelling, decisive vision, which is a prerequisite for innovation. We also can explore new ways of communicating vision, both in on-line written form and perhaps in short films like *Knowledge Navigator*. I don't think we'll ever have the agility and speed of a small project team in formulating family-wide vision, but I still think we can still come up with some powerful innovations, even ones which require cooperation across the organization.

Those are my thoughts for helping us formulate vision in a giant R&D organization. I also wanted to reiterate a few other points that I had brought up in earlier sections which also are relevant to growing up without growing old.

I believe that we need a counseling organization separate from HR which is trained specifically to help creative people work better together. What comes to mind as an example is the role of Counselor Deanna Troi on the TV series, *Star Trek: The Next Generation*. She is considered an essential member of the crew, providing insight and perspective, and she is always there, not just when trouble arises. Our Apple counselors could help

identify what organizational changes in groups might help groups work more effectively, and they could anticipate and short-circuit impending personality clashes. They would also treat both managers and employees equally, providing balanced advice and insight on both sides. Unlike managers, these counselors would be professionals in the psychology of highly creative people. I think that they would easily pay for themselves with the additional efficiencies realized in the R&D organization.

I think we need to overhaul the incentives programs. We need to look at everything including the bonus plan, the stock option plan, and the various award plans. We need the input of some of the people who are the subject of these incentive plans as well.

I believe all managers should be *required* to take certain management training *and* evaluation courses before they are thrust into the role of management. I don't think they should be allowed to manage people before they are considered minimally certified for that role. Our future relies on our ability to cultivate our people. We need strong, capable management to accomplish this task.

To summarize my recommendations: 1) We need an architectural organization for each product family, made up of architects appointed from each constituency in R&D. 2) The architectural organization shall specify the vision for each subsystem, coordinating them all into an overall vision for the product family. 3) We need an organization of counselors trained to work with highly creative people to make recommendations on how teams can more effective. 4) We need to overhaul our incentives program. 5) We need to require new managers to take training and evaluation courses before they are allowed to manage people.

And so I've put my neck on the chopping block with some concrete recommendations. All I have left is a few remarks to make to my friends at Apple.

9. Afterword

O! for a Muse of fire, that would ascend
The brightest heaven of invention!

—Henry V, *William Shakespeare*

I say there can be no safety for these States without innovators—without free tongues, and ears willing to hear the tongues.

—*Walt Whitman*

A colleague of mine pointed out that in the philosophy of *I Ching* the symbol for crisis is also the symbol for opportunity. I believe that the recent changes at Apple, rather than reflecting a crisis, represent a great opportunity to restructure the R&D organization to be more supportive of innovation. I am confident that even as a ten billion dollar corporation there is a way that we can still turn out the most innovative products in the industry—there is no reason we can't be the Sony of the 1990's. And, I am certain that someday Apple can once again be a world-class haven for innovation and innovators. I hope that some of the ideas I've shared in this document will help Apple towards these ends. We must bring innovation back to Apple again.

I want to thank the people who have diligently reviewed the many drafts and versions. The paper is far better because of your contributions. Also, I especially want to thank those few friends that stuck by me through the most difficult time of my life. I will never forget your help.

"ANAH NAHTHRAS OOSFAS DEFAHD DOECHYEL NIENVAY"