Enrollment Management, Managing the Alpha AXP Program

1 Abstract

Digital's multiyear Alpha AXP program has involved more than two thousand engineers across many disciplines. Innovative management styles and techniques were required to deliver this high-quality program on an aggressive schedule. The Alpha AXP Program Office used a four-point methodology for management: (1) establish an appropriately large shared vision; (2) delegate completely and elicit specific commitments; (3) inspect rigorously, providing supportive feedback; (4) acknowledge every advance, learning as the program progresses. We consciously used each project event to propel progress and gain momentum. Digital delivered the Alpha AXP program on schedule with industry-leadership capabilities.

2 Introduction

The program to develop the Alpha AXP systems has been the largest in Digital's history and one of the largest in the computer industry. During the course of the program, the Alpha AXP Program Office developed a model that provided the tools necessary to manage the program. At times, this paper may seem to imply that the program team developed the tools and then used them in a pure form. In practice, the team developed these approaches based on many years of experience and on the management theories of experts; we also learned and applied these lessons as we managed the program.

Although the positive effects of timely delivery and high quality are particularly noticeable results of such a large program, Digital has also used the tools to good effect on smaller projects. Moreover, teams within the Alpha AXP Program used the tools recursively, project by project. The author's experience is that this management model is applicable to projects of nearly any size.

The discussion that follows briefly defines the scope of the program and explains why traditional methods were inappropriate for managing the development of such a complex product set in a short time period. The Enrollment Management Model and the concept of cusps-a key element of the model-are then defined and clarified through discussion of the model's evolution during the Alpha AXP Program.

Size of the ALPHA AXP Program

Digital's Alpha AXP program encompassed the design of a world-leadership microprocessor chip, a new 64-bit system architecture, multiple hardware systems (from personal computers to mainframes), multiple operating

systems, and hundreds of software products layered on these systems. The development of the first-generation products extended over several years and involved more than two thousand hardware, software, and systems

engineers at its peak. Digital managed the overall development program from a Program Office staffed by eight professionals.

Across Digital worldwide, the Alpha AXP program development spanned more than 22 software engineering groups and 10 hardware engineering groups. The hardware effort included the semiconductor design group and groups for each of the hardware systems platforms. The software efforts encompassed four operating systems groups, and groups designing migration tools, network systems, compilers, databases, integration frameworks, and applications. Some groups peaked at more than 150 development engineers plus supporting staff. Many also contracted with suppliers both within and outside Digital.

Inappropriate Organizational Approaches

Implementing such a broad, complex program presented not only technological challenges but a management challenge as well. The Program Office therefore considered and rejected a number of traditional organizational approaches.[1]

In the classic organizational model, a hierarchical, or line, organization is formed, containing all the primary implementers. The problem with this approach to large programs is that it takes too long to form the organization. Staffing the teams and establishing operational procedures take longer than the market window and available technology allow. The result is grand visions and projects delivered years behind schedule. Further, "temporary" organizations must be folded back into the mainstream at the end of the program. The management goal of the Alpha AXP Program was to keep expertise concentrated to achieve synergy across many projects within a particular discipline.[2]

An alternative approach is to form small entrepreneurial teams and challenge them to work long hours to achieve the goals. This works well in small projects suitable for "skunk works." The original design work was conducted in this fashion. However, when this approach is applied to large programs, the result is that team members burn out without achieving the aggressive schedules demanded. Management then becomes frustrated and tries again with different teams, but the results are no better.

The Program Office established the Alpha AXP program as an integration of project teams that would remain within the existing line organizations. Thus, for example, each hardware and software project resided within its functional group (semiconductors, servers, OpenVMS, UNIX, compilers, database, CPU development, networks, etc.). The Program Office integrated the work of the individual project teams, which provided the additional advantage of program resilience in the face of functional group reorganizations.

3 The Enrollment Management Model

The Enrollment Management Model (Figure 1) for the Alpha AXP program comprises four stages.

- Vision-Enrollment
- Commitment-Delegation
- Inspection-Support
- Acknowledgment-Learning

The model in this form was developed by the author. Some elements are derived from management seminars and from consultants' recommendations. The particular forms used for vision, commitment, and acknowledgment emerged during the Alpha AXP program. The inspection-support stage was developed by the author during many years of project management and reviews.

Two concepts are key to implementing this model for large programs. First, the Program Office, which has already been mentioned, provides the necessary cohesion, program vision, and inspection structures, while allowing the skills and resources to remain within their natural organizations. Moreover, the office lends consistency across the program and encourages each contributing group to hold to its commitments. The small Alpha AXP Program Office, made up of a diverse group of product and operations managers, had no formal authority (not even budget authority); so it exerted influence only through rigorous enrollment and delegation outlined by the management model.

The second key concept is the project "cusp," which is a critical event that propels change. Cusps are further defined in the sections Inspection-Support and Using Project Cusps below.

Vision-Enrollment

The Program Office uses vision to enroll the related groups in the goals of the program. For example, the vision can be the top-level business goals and customer needs. For subordinate projects, the vision can be the objectives of the larger project. In all cases, the enrollment happens only when the goals are set in the context of the audience (the project team). In particular, the Program Office is most effective when it expresses the program's vision in the terms and language of the group being enrolled. The vision has to be large enough to encompass all the required commitments and the ultimate results.

Commitment-Delegation

As the manager of a project develops plans, he or she delegates the tasks to sub-groups and solicits specific commitments to content and schedule.[3] Since these commitments are made within the context of the larger vision, the subordinate commitments become quite strong for sub-project members. A key element of the delegation process is the explicit specification of the results such that they are measurable and identified with an individual

owner. The owner is a single individual empowered by the committing group and held accountable for the deliverable.[4] An important point here is that the term "owner" does not necessarily refer to the person who actually does the work. The owner is responsible and therefore accountable for getting the work done on time. In our particular program, the Program Office had to clarify and reinforce this distinction carefully as part of the enrollment stage.

Inspection-Support

The project manager trusts in the commitments made and continually inspects the project to ensure delivery on schedule. This inspection strictly takes the form of supportive feedback, thereby encouraging people to disclose risks before they become problems. Whenever the projected results are at risk of falling short of the commitment, the project manager declares a project "cusp."

The term "cusp" is adapted here from Gleick to describe the potential turning points, or critical events, in a project.[5] (Other terms in conventional parlance include "gotchas," setbacks, crises, turning points, project breakdowns, and "calls to action." The managers used these terms during the program. For our purposes, we adopt the term cusp as an emotionally neutral term. It is important that at any point in the project the term used be one that gives an opening for the possibility of making a difference and for moving the project forward.) At the point of a cusp, everyone is ready to embrace change because it furthers the overall program objectives.

The management team collaborated to take advantage of cusps to propel project momentum toward the established goal. Examples of cusps in the Alpha AXP program are presented throughout this paper to demonstrate their integral value in the application of the Enrollment Management Model and the role they played in the creation of the model itself.

Acknowledgment-Learning

At each step of the project, the Program Office acknowledges progress both personally and publicly. For each event, the management team repeatedly asks what was learned and how managers and the team can do even better next time. Teams are frequently coached to improve their methods for better results.

Using the Model

In principle, the Program Office used the Enrollment Management Model in each component project. Of course in practice, not all groups used this methodology. Early in the program, only a few groups signed up. As the

Alpha AXP Program Office began organizing the overall program, we started formalizing the methodology. As noted above, we learned extensively as events progressed. We found few useful manuals applicable to running such a large program effectively. Instead, the Program Office developed many of the tools "on the job," learning as the project unfolded.[6] This

paper exaggerates a pure model rather than presenting its incremental development. To balance the picture, we show some of the pitfalls and side paths.

Most project managers followed the Enrollment Management Model either by instinct (experience) or by example. In several instances, they formally reached outside for training in running projects of this complexity. Depending on the size of the project or sub-project, managers used the model with varying degrees of rigor. For example, the larger projects and the program overall used formal inspection meetings and reviews. Subordinate projects were free to use formal or informal inspection processes. The program team inspected each group's inspection processes to ensure that there would not be any unfortunate management surprises.

Using Project Cusps

As described earlier, cusps are critical project events, or crises. Conventional project management concentrates on rigorous planning to avoid such crises. The Program Office took the opposite approach: We strove to understand the critical events and milestones and used these cusps to increase project momentum, as Figure 2 illustrates. As the project approached each cusp, the Program Office dealt with the event promptly to ensure that the project continued to move toward the overarching goal. In other words, the managers did not develop a plan just to follow the plan. Instead, they developed a plan to understand the overall project flow and used the milestones and other events as opportunities to adjust the project velocity to keep moving toward the goal.[7] In many cases, we generated a cusp to propel the necessary change (for example, by creating a schedule crisis). In other cases, we took advantage of a cusp to make a necessary change.

As the management team became comfortable with using project cusps constructively, the Program Office actively solicited more of them. These increased the velocity and resulting momentum of the program, thereby achieving a "slingshot" effect. The Program Office used each cusp to acknowledge progress. As the team acknowledged more and more progress, the program's momentum moved from very low to break-even, and finally into high gear.

4 Vision-Enrollment Stage: Magnitude of the Program's Vision

The vision for a program or project becomes the ultimate goal or deliverable. Thus, the Alpha AXP Program Manager's first task was to establish a vision shared by all groups that would contribute to the program. This vision had to be large enough to encompass all the work.

Alpha AXP Systems as Fifth-generation Computing

The Alpha AXP family is at the confluence of five major trends in computing.

1. Nineteen ninety-two is the first year in which it is feasible to achieve 64-bit computing on a single microprocessor.

2. Nineteen ninety-two is the first year in which microprocessors have achieved over 100 MIPS (million instructions per second) of computing.

3. It is now cost-effective to place more than 4 gigabytes of main memory on a system; hence 32-bit addressing is insufficient.

4. Networking technology now allows the construction of networks with over 100-megabit throughput.

5. Cost-effective storage systems now exceed the many-gigabyte range and are approaching terabytes.

These computing systems will include large amounts of parallelism as compared with classical designs. The levels of performance and connectivity finally allow computing to realize greater human productivity: mobile, highly interactive computing that supports group work with algorithms that intelligently analyze, simulate, and synthesize in support of a wide variety of human endeavors. The application of this technology qualifies as the fifth generation of computing.[8,9]

The program vision for Alpha AXP systems, as shown in Figure 3, is to be the first family of systems to implement the technology and applications for the fifth generation of computing. This family is fully compatible across all members now and will be into future generations, ensuring

that application binary programs will run unchanged. With no compromise to future performance, the initial family members also maintain a high degree of compatibility with current systems to allow easy migration for customers as they begin to require this technology. Delivering a family of high-quality systems in a timely fashion reestablishes Digital's reputation for technology and systems leadership.

Getting Started

The Alpha AXP program grew out of research on computing, specifically the technology and benefits of different RISC (reduced instruction set computing) architectures, and from advanced development in compiler designs, VLSI (very large-scale integration) design, and semiconductor fabrication. In 1988, Digital's Executive Committee challenged Engineering to develop a system that would meet the customers' needs for competitive performance in all of Digital's computing environments. Engineering formed a cross-disciplinary task force that developed the requisite systems architecture and designs and produced the above vision and hence the Alpha AXP program. Digital's Executive Committee approved the Alpha AXP program in October 1989.[10]

First Cusp: Executive Challenge to Accelerate Schedule

By the end of 1989, Digital had completed the advanced developments and signed off on the architecture and primary design documents. In a major review during January 1990, upper management challenged the program to improve the schedules to capture the market window for this new technology. The project managers understood the rationale for this demand but could see no way to meet the aggressive schedule. The result was a loss of rapport between management and the technical staff, with comments such as "Don't talk to me about crazy schedules" and "This is just going to be a lot of hard work."

The Program Office viewed this cusp as an opportunity rather than the crisis that it appeared to be. The office enrolled key project managers in the overall vision, i.e., in the business value of a timely execution. For some projects, it was sufficient to focus on the classic "time-to-market." However, for many, the ship date proved an insufficient motivator. Therefore the Program Office framed the vision differently, as follows. A program becomes profitable when it reaches break-even (i.e., cumulative revenues meet and then exceed cumulative expenses).

The time taken to achieve this point is known as the "time-to-profit."[11] The Program Office estimated that the program's schedule would affect Digital's revenue at the rate of $1 million per hour. That is, for each hour that the project could improve (lower) the time-to-profit, Digital would achieve an additional $1 million of revenue. The Program Office pointed out to the project managers that this revenue could translate to approximately $0.01 on the stock price for each hour of schedule improvement. With this concrete business metric in mind, the key project managers were willing to consider new ways to tackle the program's challenge.

Once the Alpha AXP program was approved, the Program Office began holding

Alpha AXP quarterly review meetings. At these forums, groups reported plans and progress to a wide, cross-disciplinary audience. Initially, the audience was composed of engineering, manufacturing, and service groups. As the program gained momentum, other disciplines such as marketing and sales joined and began to report on their own progress. These forums helped

generate belief and solidify enrollment. They also helped the Program Office identify problem areas before they became crises.

First Cusp Result

We established a program-wide understanding of the importance of volume deliveries in 1992.

5 Commitment-Delegation Stage: Delegating and Eliciting Commitment

With the key project managers sharing a common vision, the next step was to establish a work plan and to ensure that each group committed to deliver on its parts.

It had been 15 years since Digital attempted to change simultaneously its architecture, hardware, operating systems, compilers, and other layered products. Since the introduction of the VAX systems in the fall of 1977, each component had progressed relatively independent of the development schedules of the others. Fewer than half a dozen project team members had participated in the VAX design. For most participants, the system had always been in existence, and hence the developer of each subsystem could invoke and depend on the existence of all the other subsystems.

The need for the simultaneous development of multiple hardware and software systems complicated the coordination task. The Program Office addressed this complex coordination in two dimensions: technical and project management. In the technical dimension, the office formed a team of technical leaders from the core engineering groups, known as the EJST, shown in Figure 4. (EJST is an acronym for EVAX Joint Systems Team. EVAX was an early name for the Alpha AXP program. An earlier forum, the EVAX Technical Team, merged into the EJST process over time.) This group met weekly to set directions for important cross-group technical design and strategy issues. Since the group's charter was to resolve problems and ensure that solutions "stuck," the EJST became a group to which others brought technical problems for resolution.

In the project management dimension, the program manager formed a team of project managers. Members of this team were empowered by their contributing engineering development groups to make commitments and to be accountable for deliverables. This team was known as the ASPM (Alpha AXP System Project Managers). Given the magnitude of the overall task and the complexity of fully understanding the interdependencies, the project managers tended to view the project as impossibly complex. At the program level, the challenge then became to establish the Alpha AXP master plan. A master plan, however, evolved much more slowly than expected.

Second Cusp: Cannot Choose the Order of the Work

Management's inability to provide an overall plan induced a crisis of disbelief. The project managers threatened to revolt (or move to other projects). The technical leaders were generating ever-larger design documents. The engineering development group managers declared that the Program Office had a crisis on its hands: We had to establish a program-wide work plan that showed the order in which each sub-project must deliver its contribution.

How does one coordinate without a plan? The Alpha AXP program manager kept asking the individual groups for their plans. What do you depend on? How long will it take? What resources do you need? What are your milestones or metrics of progress? The repeated answer was "I don't know because I don't know what everyone else is doing and when they will be done with their piece." At this time, we had already established the cross-functional ASPM team of experienced project managers representing most of the development groups. This team was unable to develop the component plans because they lacked a master plan.

Choosing the Strategy

The engineering development group managers met in a full-day meeting to establish the overall parameters of the Alpha AXP program's plan. First, they established the business goals and examined the various technical constraints. The group tested the inclusion of each component with the question "Is this component critical to the overall business success of the Alpha AXP program?" This process established solid reasons for the contents of the master plan and kept the responsibility for the inclusion or exclusion of a component with the responsible development group. The group then determined the organizational implications of such a work plan. Members of the group balanced the dimensions of business, technology, and organization to establish the priorities and work order. We institutionalized this group into the Alpha AXP System Board of Directors (ASBOD).

Representing the Plan

With the major program priorities and constraints established, the Alpha AXP program manager then set off to establish the master plan. For all groups to see their contributions, he held the master plan to a single page. He established the content during an intense period in which he asked contributors to describe their assumptions and tasks and to show where on the overall plan their pieces would fall. The single-page format forced the management team to keep the plan to a high-level view and allowed contributors to see their pieces without adding the complexity of their own group's details. Further, in review meetings it was easy for everyone

in the room to view the same picture so that the results could be seen, debated, and agreed upon.

Once the management team had outlined the plan, it was recommended by the project managers (ASPM) and approved by the engineering development group managers (ASBOD). Thus team members knew their goals would not change without clearly stated reasons. Further, others could start building their plans based on a consistent set of assumptions. The resulting single page also became a reference, which we called the "straw horse," to establish and reinforce constancy of purpose. Figure 5 is an example of the Straw Horse Plan. (We later upgraded the name to be the "tin horse" to connote the increasing degree of solidity of the underlying plans and commitments.)

Second Cusp Result

We agreed on the overall single-page plan upon which teams could build their own plans.

Enrollment and Delegation: Value of Each Contribution

With the master plan outlined (the straw horse reviewed and approved), the next step was to obtain the commitment of each contributing group. To address continuing skepticism about the necessity of each component and its schedule, the program manager walked each group through the overall program and the economic value of its urgency. The group was then asked to contribute to the overall system's value. A key prerequisite to this conversation was to establish a full-time project manager for each component group, who became the coordination point and who was held accountable for each deliverable.

Decide What to Do before How to Do It

The Program Office found that each group went through a disbelief process similar to the one seen earlier for the program. The program manager urged each group to first focus on the "what" of their deliverable, before trying to decide the "how." The program manager ensured that the group grounded its overall estimates in reality. For example, a software group might count the number of modules to port and estimate the person-days per module. This kind of high-level, quantifiable estimate allowed the project manager to make an overall estimate without needing to understand the order of the specific tasks.

Third Cusp: Need for Project Management Expertise

Members of several of the larger projects determined that they did not have sufficient project management experience. Previously, this realization would have resulted in replanning to move out the target schedule, perhaps repeatedly. Instead, given the group's commitment to the larger result, we found a much more aggressive behavior. For example, the OpenVMS AXP group publicly committed to their target schedule and stated, "We don't know

how to achieve this, but we commit to finding a way." The next day they went to a project management consultant for training on how to build an aggressive, attainable schedule. This consultant conducted the seminar many times throughout the project for various groups.[12]

Enrollment Management, Managing the Alpha AXP Program

Third Cusp Result

Groups introduced education and rigor into project management.

6 Inspection-Support Stage: Inspection with Supportive Feedback

One of our vice presidents in the early 1980s had an aphorism: You get what you inspect, not what you expect. In other words, a common failing is that managers obtain someone's promise and expect that the results will be what they expected. Unfortunately, despite everyone's best intentions, circumstances and unexpected requests can easily divert the promiser away from fulfilling the promise. Thus, managers learn to inspect regularly the progress of groups on whose commitments they depend.

The model, therefore, incorporates this traditional, essential project management practice. Its inclusion was prompted by another project crisis, described below.

Fourth Cusp: Project Slips Motivate Formal Operational Inspection

The Program Office knew that it was working with highly motivated teams. On the basis of the earlier planning work, we assumed that they were all tightly focused on the objectives of the Alpha AXP program and shared our sense of schedule urgency. Suddenly, we were shocked by a memo stating that a critical project's schedule had slipped several months. Since virtually every other project depended upon it, this schedule slip could easily have led to a program disaster. Instead, we used the event to institute a regular operational inspection. Often, instituting such regular reviews is difficult and generally resisted by the reviewees. In this case, every group could see the danger of continuing without regular inspections and readily agreed to this new process.

The Program Office adopted the term "inspection," rather than "review," because we have found this term to be neutral or positive. In the past, reviews had been imposed by line management and tended to encourage the reviewees to cover up issues until it was too late to recover. In contrast, the program manager, operating under the Program Office model, had no line authority and set up the monthly operational inspections in an open and supportive environment. The presenters were the designated project managers from each development group. The Program Office encouraged all presenters to bring in their risks and problems before it was too late to address them effectively. We used the single-page format again, as shown in Figure 6. Note that the simple, visual history of all milestones is at the top, so one can readily see any repetitive slips. The emphasis is on critical path events completed last month and those coming up next month. At the bottom are listed those issues that have been resolved and issues being opened, with clearly indicated ownership and due dates.

Operational Excellence

To ensure that every project implemented the strategies, the Program Office

established the principle of operational excellence across the Alpha AXP program. The office consistently recognized teams that accomplished their results on time and predictably. We also used the monthly program-wide inspections to maintain a published record of progress. Thus, each project

was encouraged to excel operationally and to learn from the experiences and presentations of the others.

Fourth Cusp Result

The Program Office establish monthly inspections using a consistent single-page document to record pertinent information.

7 Acknowledgement-Learning Stage: Building Momentum

Developing the vision and plan resulted in a general sense of euphoria. Shortly afterwards, the reality of the work ahead descended like a cloud of despair. At this point, the primary challenge was to start building momentum in the program. In the Enrollment Management Model, building momentum-the acknowledgment-learning stage-is tightly intertwined with the inspection stage; that is, events reported during inspections were used to build momentum. The Program Office reinforced the vision and used momentum building to minimize the time period during which the team felt despair about the work ahead.

Fifth Cusp: Despair

Since the overall program had such a formidable goal, many of the contributing teams became stalled with the magnitude of the task ahead of them. This manifested itself in the form of comments about the large amount of work, the resulting potential for schedule delays, and a fear of overtime demands. This syndrome is common in any large project, especially when commitments are made that involve taking large risks. The approach the program team took was to start recognizing each element of progress. As we distributed announcements of progress widely (using Digital's worldwide electronic mail network), we began to build momentum around the Alpha AXP program. Other groups picked up on this momentum and contributed to it themselves. This effect cascaded throughout the entire program-more groups perceived their tasks ahead as achievable; rapidly each group wanted its own progress acknowledged; and momentum increased.

The Program Office found that the members of a project appreciated and were motivated by the simple "thank you" represented by the public acknowledgment of their work. This contrasts with the conventional management wisdom that it is necessary to give frequent monetary rewards to motivate people. Although everyone appreciates the financial rewards, the biggest motivator is the professional recognition that the contributor did a good and necessary job!

The second benefit of the acknowledgment was its effect in creating a sense of momentum throughout all the project teams. Repeatedly, peer managers would comment that the Alpha AXP team was making significant progress. This in turn gave us a sense of accomplishment as well. So the program realized a double benefit from the original acknowledgment and a further slingshot effect with recognition coming back to the Program Office.

Fifth Cusp Result

Program-wide, managers established the norm of frequent acknowledgment of progress.

As the Alpha AXP program made further progress, the Program Office actively solicited third-party and customer involvement. This involvement provided good feedback on progress and had the effect of reinforcing the fact that the program was on track to meet customer needs. In some cases, the project

teams altered the Alpha AXP plans to better help our customers address their business needs. This further contributed to the credibility and momentum of the program as well as the sense of accomplishment.

Sixth Cusp: Broken Dependencies and Replanning

Like any project, not every assumption and dependency proves to be correct or totally accurate. At one point, one of the major Alpha AXP hardware systems slipped its schedule for delivery of prototypes to software. After considering a number of alternatives, the operating system group proposed an alternate plan using a different hardware system and a changed order of events. They said in their management presentation at the time, "The question is not one of blame. Instead our goal is to preserve the ultimate schedule goal of the program, specifically its volume availability date."

Sixth Cusp Result

Program-wide, team members established the principle of focusing on the desired state of time-to-profit rather than on blaming others for failures.

At another point, one group was at risk because it needed a critical skill for a week. A (historically) competing hardware group responded by asking what sort of resource, and then freely supplied the resource despite its own very tight schedule. In the past, these groups would compete for the same resource without collaborating for the common good.

Seventh Cusp: Incomplete Assumptions and the Need for the Performance Team

Less than half way through the Alpha AXP program, the program team realized that some projects' assumptions were incomplete. RISC systems are notorious for requiring careful design and tuning to meet aggressive performance goals. Evidence from a related program at Digital suggested that some of our system performance homework was weak. The Program Office quietly asked the appropriate teams to assign some resources to measure key components and subsystems of the design. This confirmed the program team's concerns that the current plans were incomplete. Quickly, we pulled together a cross-disciplinary task force to analyze the information rigorously and to make recommendations. These analyses resulted in changes in the architecture, the chip design, the systems designs, and the software. The changes have proved to increase performance substantially.

Seventh Cusp Result

The program established a performance team to change the design and plans as needed.

Eighth Cusp: Prototype Allocation Process

As manufacturing started to deliver prototypes, the Program Office found that the early manufacturing build rate was lower than planned. This was the result of normal start-up problems. At the same time, initial demand had increased substantially. Nevertheless, the project administrators continued to ship the systems to engineering and applications groups in

the original order. If this had continued, dependent software would have been delivered progressively later because of inadequate testing cycles. Our impact analysis indicated that the Alpha AXP volume availability would slip by three months.

The review team highlighted this problem in an early program readiness review. Traditionally, Digital uses readiness reviews to establish manufacturing's readiness to build systems. The Alpha AXP Program Office broadened this process and asked for a program-wide readiness review to identify the "showstopper" risks. As a result, the Program Office centralized the allocation process so that we could maintain the prototype allocations in real time. The result was to reestablish sufficient software test time and maintain momentum with minimal program impact.

Eighth Cusp Result

The program teams decided that prototypes would be delivered based on program priorities, not solely on existing plans.

Ninth Cusp: Need for Quality Metrics

Each group in the Alpha AXP program adopted very high standards for the quality of its work. The management team repeatedly found reinforcement of Phil Crosby's dictum: "Quality is free."[13] Results in group after group showed that early and continuous attention to quality resulted in held or improved schedules.

However, the program team noticed that we were not inspecting and measuring progress in quality at the total systems level; customers care about only the quality of the total result. As the projects started integrating into a total system, the Program Office established an independent group to measure overall quality levels. The classic reaction to such independently derived quality metrics is that they are meaningless. Instead, since the program established the metrics at the moment when everyone saw the need, the reaction has been to focus on the total system's quality without dropping attention on the individual component metrics.

Ninth Cusp Result

The program formalized system-wide quality metrics.

8 Results and Lessons

Digital met exactly the program's overall schedule to the month (i.e., date for high-volume shipments), despite numerous setbacks along the way. The Alpha AXP system is meeting the original performance goals, and quality is excellent. Digital's Board of Directors has approved the full Alpha AXP

program business plan and the investments necessary to capitalize on the Alpha AXP family's early successes. Initial reactions from customers have been favorable. Third parties have committed Alpha AXP support for their products in record numbers.

What Worked Well

The Program Office in conjunction with the Enrollment Management Model has worked well. If the management team had followed traditional approaches, we would still be getting organized. Using the model, each group has been able to bring its full capabilities to bear as problems have arisen. The project teams have accepted the introduction of multiple levels of inspection, and other programs within Digital are copying this aspect of the model. Further, the notion of using project cusps creatively has been an effective tool to build momentum. Finally, a common schedule and inspection discipline allowed the schedule to become an opportunity to reinforce a shared vision. This positive view contrasts with the conventional interpretation of a schedule as a burden.

As a result, most groups met very aggressive goals on schedule. Several groups accelerated their deliverables despite having the most complex tasks. For example, the OpenVMS AXP system group not only met its original schedule but also accelerated numerous deliverables into earlier base levels or releases. Figure 7 shows the OpenVMS schedule and actual dates of availability; footnotes indicate functional accelerations. The networks group delivered DECnet on the AXP system an entire base level early. The database systems group accelerated its schedule by several months and demonstrated products four months early at Digital's DECWORLD '92 trade show.

Clearly one of the major lessons was to establish a constancy of purpose and hold to it while continually learning and updating the detailed plans. The single-page representation of the goals and master plan is a key element in maintaining this constancy.

What We Would Do Differently

Looking back, we would have approached the program differently in two areas. First, project teams would have benefited from broader early education on project methodology. Several projects had significant slips, causing undue hardship on other groups. The Program Office should have introduced Ron LaFleur's project methodology sooner and pervasively. Instead, we waited until each group saw the need and then tried to introduce it. For groups such as the OpenVMS AXP system group, the methodology was introduced early. However, other groups needed (and still need) this discipline.

Second, the office would have conducted more pervasive project inspections. Several groups were very late in producing schedules and plans that the Program Office could understand. The office was unable to obtain their cooperation to hold detailed and frequent inspections. Eventually, the Program Office was invited to set up and participate in appropriate

inspections of schedule, process, etc. However, we should have insisted on these much sooner.

9 Summary

The Alpha AXP program is the most complex program in Digital's history and has been delivered on schedule with high quality. The Alpha AXP Program Office used a rigorous management methodology to build the program-level teamwork necessary to accomplish this breakthrough. The office proved the effectiveness of the Enrollment Management Model: vision-enrollment, commitment-delegation, inspection-support, and acknowledgment-learning. Integral to this model and empowering to the team is to take each cusp head-on and to use them to increase momentum. The management team has been learning as the program progressed and has identified areas needing strengthening for future programs.

10 Acknowledgments

The author thanks the following senior managers for demonstrating the importance of good management: Gordon Bell for architecture and a clear strategy; Ken Olsen for demanding simple, single-page plans; Jeff Kalb for operational excellence; David Stone for the model of focusing on the desired state; Bob Supnik for the paradigm of the Program Office.

The author also thanks key members of the Alpha AXP Program Office for their contributions in managing the program and developing the Enrollment Management Methodology: Al Avery for systems integration and significant help preparing this paper; Scott Gordon for competitive benchmarking; Ellen Salisbury for planning; and Ken Schultz for operations and inspection.

11 References and Note

1. R. Waterman, T. Peters, and J. Phillips, "Structure is Not Organization," Business Horizons, no. 80302 (June 1980).

2. C. Savage, Fifth Generation Management (Burlington, MA: Digital Press, 1990).

3. W. Oncken and D. Wass, "Management Time: Who's got the monkey," Harvard Business Review, vol. 18, no. 6 (November 1974): 75-79.

4. M. McMaster and J. Grinder, PRECISION: A New Approach to Communication (Bonny Doon, CA: Precision Models, 1980).

5. J. Gleick, CHAOS: Making a New Science (New York: Penguin Books, 1987).

6. P. Senge, The Fifth Discipline: The Art and Practice of the Learning Organization (New York: Doubleday, 1990).

7. A. Scherr, "Managing for Breakthroughs in Productivity," Human Resource

Management, vol. 28, no. 3 (Fall 1989): 403-424.

8. L. Tesler, "Networked Computing in the 1990s," Scientific American (September 1991): 86-93.

9. The five generations of computing are as follows: 1950s, standalone; 1960s, batch; 1970s, timesharing; 1980s, personal; 1990s, mobile distributed.

10. R. Comerford, "How DEC Developed Alpha," IEEE Spectrum (July 1992): 26-31.

11. C. House and R. Price, "The Return Map: Tracking Product Teams," Harvard Business Review, vol. 69, no. 1 (January 1991): 92-100.

12. R. LaFleur, "A Seminar in Project Management" (Scituate, MA: Project Management Assistance Co., 1990).

13. P. Crosby, Quality Is Free: The Art of Making Quality Certain (New York: McGraw-Hill, 1979).

12 General References

F. Brooks, The Mythical Man-month: Essays on Software Engineering (Reading, MA: Addison-Wesley, 1975).

R. Neustadt and E. May, Thinking In Time: The uses of history for decision makers (New York: The Free Press, 1986).

13 Trademarks

The following are trademarks of Digital Equipment Corporation:

Alpha AXP, AXP, Digital, OpenVMS, VAX, DECnet, and DECWORLD.

The following is a third-party trademark:

UNIX is a registered trademark of UNIX System Laboratories, Inc.

14 Biographies

Peter F. Conklin Peter Conklin is director of Alpha AXP Systems Development. Since joining Digital in 1969, he has held engineering management positions in large and small systems and terminals groups, direct hardware and software engineering, product management, base product marketing, quality management, and advanced development. Peter was the first software engineer on the VMS project in 1975, ran the VAX architecture team, and was instrumental in developing the key architectures and products for the VAX VMS layered product set. Peter received an A.B. in mathematics from Harvard University in 1963.