Early Career Hire Rapid Training and Development Program: Status Report

Betsy N. Riley[1], Benjamin S. Solish[2], Lauren Halatek[3] and Richard R. Rieber[4]
Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, 91109

The aging of the industrialized workforce, particularly in the aerospace industry, has resulted in a very large generation gap in the workforce. The disproportionate size of Baby Boomers, increasing longevity and declining birth rates has made this phenomenon a reality that no organization can ignore. It is now critical that aerospace organizations prepare themselves for this watershed transformation in the workforce and take the initiative to prepare the incoming workforce with the skills and knowledge necessary to stay at the forefront. Last year the Jet Propulsion Laboratory launched a pioneering training program, known as Phaeton, to provide the knowledge, practice, experience, mentoring opportunities, and project life cycle exposure to our incoming generation of engineers. After 14 months of operation, now is the time to discuss the preliminary results of this new program.

Nomenclature

CDR = Critical Design Review
ECH = Early Career Hire
ISS = International Space Station
JPL = Jet Propulsion Laboratory
MCR = Mission Concept Review
NASA = National Aeronautics and Space Administration
OPALS = Optical Planetary Access Link for Space Station
PDR = Preliminary Design Review
PMD = Phaeton Mast Dynamics
PRB = Phaeton Review Board
RFC = Request for Concept
SRR = System Requirements Review
TRaiNED = Terrain Relative Navigation and Employee Development

I. Introduction

NASA faces a significant challenge in the near future as the unprecedented shift in the age distribution of the workforce. NASA employs veteran scientists and engineers who have a lifetime of experience working with the Shuttle, Apollo, ISS, Skylab, and hundreds of other spacecraft and aircraft. However, the reality is that NASA's workforce is aging at an alarming rate. The average NASA full-time, permanent scientist or engineer is 47.9 years of age as of June 6, 2009, and is growing relatively linearly at a rate of 0.34 years of age annually (Fig 1). Furthermore, 37% of all scientists and engineers at NASA are eligible to retire today, up from 26% in 2004[1]. These statistics do not necessitate a mass of simultaneous retirements, but they do highlight the uncertainty of NASA's human capital

[1] Betsy N. Riley, Organizational Development Specialist, Human Resources, 4800 Oak Grove Dr. M/S 179-206, Pasadena, CA 91109.
[2] Benjamin S. Solish, Associate Systems Engineer, Mars Mission Concepts, 4800 Oak Grove Dr. M/S 301-445, Pasadena, CA 91109.
[3] Lauren M. Halatek, Associate Systems Integration Engineer, Measurement Services, 4800 Oak Grove Dr. M/S 125-177, Pasadena, CA 91109.
[4] Richard R. Rieber, Associate Integration and Test Engineer, Integration and Test Engineering, 4800 Oak Grove Dr. M/S 179-206, Pasadena, CA 91109.

in the near future. This predicament makes it more critical than ever to take the necessary measures to capture as much of the wisdom and knowledge of the most experienced portion of the NASA workforce. Organizations are in a position where they need to take the initiative and prepare the incoming workforce with the skills and knowledge necessary to stay at the forefront of new research and technological and engineering practices to ensure tomorrow's success.

At the Jet Propulsion Laboratory (JPL) a new employee with only a few years of experience since their last degree is designated as an Early Career Hire (ECH). Typically, an ECH will work for many years before assuming a significant role on a flight project before finding their desired niche in the organization. For the most part, an ECH working on a flight project will hold minimal responsibility and have little effect on system- or mission-level trades. A typical career path may entail several years before an employee is given any subsystem responsibility with the potential to influence the performance, cost, and schedule of a flight project. By the time today's new hires have the opportunity to reach a position of responsibility, a vast majority of NASA's veterans may have already left the agency. There is no expectation that the competency for experienced personnel on NASA flight projects will be lessened. Therefore, NASA must inject the hard-earned wisdom from its veterans into the newer employees entering the playing field.

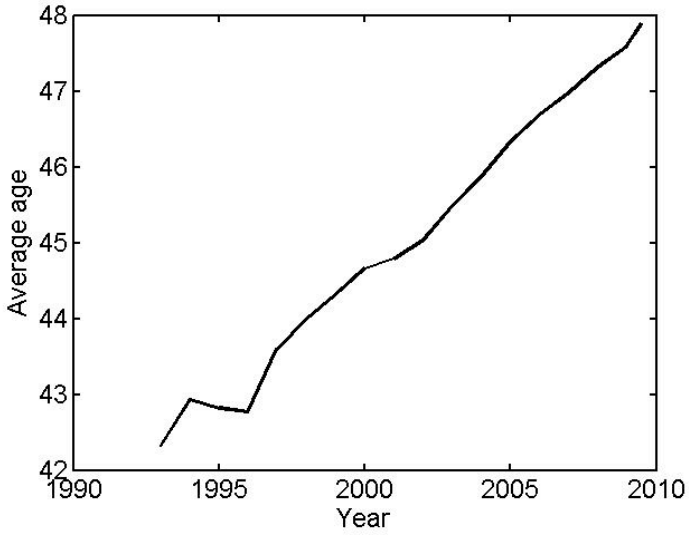

Figure 1. Average age of NASA's full-time permanent science and engineering workforce over the last 17 years.[1]

At the AIAA Space 2008 Conference in San Diego, California, an idea for a training program designed for ECHs that will address this predicament via peer-managed, peer-led, project-based learning with strong mentoring was presented. This idea was conceived and developed by a team of ECHs and has been implemented at the JPL in Pasadena, California under the name of Phaeton. With the first year of the program complete, we are providing our readers with an update on the progress of Phaeton, the challenges and successes. In this paper we will describe the key components of the program, explain how the projects work and how mentoring and training elements are all contributing to the professional development of participants. We will also explore funding challenges and the program's future.

II. Overview of Phaeton

Phaeton combines traditional training techniques – course work and mentoring – with a rapid on-the-job-training in a project-based environment. The groundbreaking aspect of Phaeton is that it provides all participants exposure to multiple design phases and subsystems within a short period of time. This program utilizes a small project environment to provide system-level, cross-phase and cross-discipline exposure. Each project starts at the proposal phase and includes design, assembly, test and operations. Participants devote an average of 50% of their time over the course of 18 months. Within this period, a participant can work directly in nearly all the mission phases of a typical project's lifecycle.

A. Project Descriptions

The fundamental training elements of Phaeton are the projects. Each project is appropriately scoped and scaled for budget, schedule, and personnel. Ideally, each project begins from the Phaeton program office with a lab-wide release of a Request For Concepts (RFC). Anyone on Lab can submit a one-page concept summary detailing a potential Phaeton project. These concept summaries are screened for the appropriate scope, budget, complexity, and training potential. The concept summaries are provided to the Phaeton participants. Small teams of Phaeton participants are formed to draft a more detailed proposal for each concept. The Phaeton Review Board (PRB) then reviews the completed proposals and selects one to be implemented. Essentially, Phaeton teams compete against one another to get their proposal implemented. All participants then work to implement the selected proposal.

When Phaeton was first inaugurated, six proposals were submitted and two projects were initially selected for implementation. The selected projects were in different stages of development, with roughly similar budgets. This project selection allowed the first group of participants to experience more stages of development in a shorter period of time. Today, we have the first two selected projects in design with a third project in concept definition. The Phaeton Mast Dynamics (PMD) project will measure and characterize the dynamical behavior of the 10-meter boom of an Earth-orbiting satellite. Phaeton's second project was secured by developing the winning proposal in response to a NASA solicitation last December for an in-house project team to fly an Earth or space-science or technology payload to be launched by the agency's Sounding Rockets Program Office in the second quarter of 2010. The winning proposal, Terrain Relative Navigation and Employee Development (TRaiNED), was developed by participants in Phaeton along with help and guidance from their mentors. TRaiNED gives the team an opportunity to work with Wallops Flight Facility to launch a payload at the White Sands Missile Range in New Mexico. This payload will collect a needed dataset to help improve terrain relative navigation technology. The latest Phaeton project, Optical Planetary Access Link for Space Station (OPALS), is currently in concept development. This project will help validate optical communication, specifically acquisition, tracking, coding algorithms, and hardware by placing an instrument on the International Space Station.

B. Selection Process

Phaeton is being utilized as a powerful recruiting tool that JPL is able to showcase what an employee might work on during their first few years at JPL. Phaeton is presented at university career fairs, on-Lab interview tours and other recruiting events. However, it's important to note that Phaeton's main goal is to train new hires and is not directly involved in hiring decisions. These decisions are left to JPL's existing management structure.

Phaeton was first announced to the JPL ECH community via an e-mail from the Phaeton Program Manager calling for participants to apply on the Phaeton website. Participants were selected for their desire to participate, availability, relevant skill, and the potential benefit the training could provide. The selection process includes a formal application and interview with concurrence from the employee's group supervisor.

During the selection of the first two projects, all participants, including the role of the project manager, were selected and staffed simultaneously. However, feedback from that initial process prompted us to change this approach by first selecting the project managers and then directly involving them with the selection of the rest of the project members. This new approach has been implemented with OPALS.

C. Oversight

The Phaeton program office consists of the Phaeton Program Manager, Lead Technical Advisor, Professional Development specialist, a business and administration specialist, and several ECHs from the original founding team who have remained in an advisory role to the program. The group, together with the project managers, meets weekly to ensure the effective management of the program and projects. The Phaeton Program Manager provides external interfaces to JPL management and partner institutions, along with program-level budgeting. The Lead Technical Advisor organizes the mentors, assigns participants to their area of responsibility, organizes project-level reviews, and ensures that Phaeton is satisfying its training goals. The Professional Development specialist is responsible for organizing the weekly training, monthly career guidance sessions, and other key training events. This specialist also administers detailed surveys of all participants, mentors, and JPL management to track participant development and ensure that Phaeton is meeting its original goals. The business and administration manager organizes Phaeton's budget and works closely with the project managers to organize each project's work-breakdown-structure.

III. Project experience

The majority of participants' training is accomplished through direct project work, where they gain valuable end-to-end experience on a small-scale mission. To supplement the hands-on training fulfilled via direct project work, participants also attend project meetings and reviews, shadow mentors, and observe the other projects in the program. This section will discuss how these objectives have been implemented, the project status and the projects' expectations for success.

A. Project Meetings and Reviews

Projects have been empowered to manage their group meetings as the project managers see fit. Both the PMD and TRaiNED project opted for a meeting structure in which a weekly tag-up meeting is held to discuss subsystems status and program announcements. In addition, small-scale working meetings are convened as needed.

Project reviews in the program mirror the standard reviews of the NASA project lifecycle shown in Figure 2. However, standard reviews are designed for traditional flight projects, which are beyond the scope of Phaeton's small-scale projects. As a result, project managers have been afforded some leeway in negotiating the scope of the reviews based on their particular projects.

In addition to the standard lifecycle reviews, the projects hold monthly reviews to report project status to the Phaeton Program manager. Quarterly management reviews are held for JPL's upper management in which group supervisors, section managers, mentors and key members of the Lab are invited. These reviews provide participants the opportunity to defend their concepts and designs against the same intense review and scrutiny that any other project at the Lab would undergo. Additionally, this experience exposes participants to the Lab's leaders for whom they will be working with on flight projects in the future.

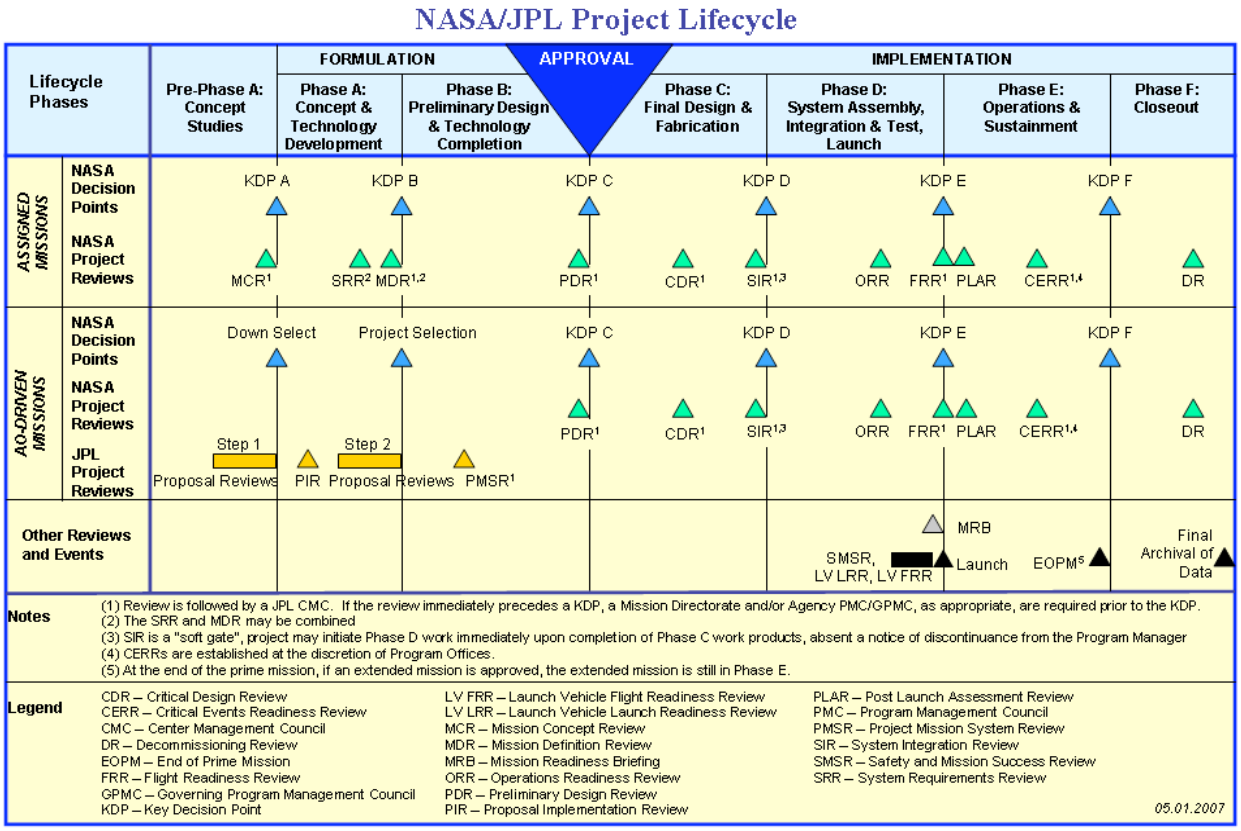

Figure 2. NASA/JPL Standard project lifecycle

B. Participants' roles and responsibilities

Participants in the program are assigned a particular discipline based on their prior experience and interest. The roles are made up of four general categories: project managers, principal investigators, systems engineers, and cognizant engineers. Each ECH is held fully accountable for their work and expected to design and formulate all supporting documents and presentations. While every ECH is assigned a mentor who can impart guidance, the final decision and responsibility belong to the ECH.

Although assigned a role in one of the three projects, each participant is expected to observe other projects. Such observation includes developing new strategies for identifying potential setbacks and implementing solutions that meet minimal resistance from management.

C. Project Status

The projects maintain their own schedules with key milestones and gate product deliverables to ensure the project stays on schedule. PMD has successfully completed their systems requirements review (SRR), preliminary design review (PDR) and critical design review (CDR) and is now in the process of building flightqualified hardware and refining the integration and test plans. The TRaiNED project has completed its SRR and is taking steps to finish the PDR. Finally, the newest Phaeton project, OPALS, is completing the Mission Concept Review (MCR) and is staffing up to start the corresponding Phase A work.

D. Project Success

Success criteria are identified during the requirements and review process. ECHs are expected to participate in, and in the case of the project manager lead the process of, determining achievable success criteria within the scope of the project–a vital training component. This allows the ECH to experience the process of discerning what is expected from them and their projects. This also requires them to weigh what they think can be accomplished with the resources at their disposal against the program's objectives and the likelihood that not all aspects may evolve exactly as planned.

Ultimately, ECHs are building projects that are advancing today's technology and producing science for JPL. Every effort is made to hold the project teams to the same standards as other full-scale projects at the Laboratory, which means it is critical for the projects to withstand the traditional rigor required to make a project successful.

IV. Mentoring

A critical element to transferring the right set of knowledge and experience is the mentoring opportunity that is provided to each participant. The program ensures that a mentor that will provide participants with the necessary guidance in their area of expertise.

A. Mentor Appointment

The Lead Technical Adviser for the program solicits experts across the Laboratory for the mentoring role based on recommendations or personal experience. The mentors are all senior level or higher with relevant experience to the role that they are mentoring. This allows for participants to build a relationship with an expert in the discipline they are practicing and work directly with mentors on a specific element of their project. Mentors typically remain with a project throughout its lifetime, providing continuity for project tasks across several responsible participants.

The majority of mentors were selected and assigned to participants starting in November 2008. However, with time and role changes, our members' needs for additional mentors surfaced. This has required Phaeton to provide additional mentors to some participants to cover the multiple disciplines they are involved in. An example of this type of scenario is the Systems Engineer for PMD, who has one mentor for structural engineering and another for thermal engineering. It's important for the program to ensure there are sufficient resources in play to fully embrace the mentoring element given that participants consider this to be the cornerstone of the program.

B. Mentor-Protégé Framework

Phaeton employs mentors on a 1:1 to 1:2 ratios. Participants also charge their time to the same account for time spent with their mentor. This configuration ensures that the mentoring of the participants is divorced from the projects themselves and therefore cannot be abolished if the projects run into obstacles. It is expected that mentor and protégé meet on a regular basis to discuss design issues, trade studies, and project planning. Mentors also participate in tabletop reviews and provide career counseling. With only a small amount of weekly time to devote, these mentors must be particularly enthusiastic and take a proactive role in ensuring that critical questions are addressed, tasks are appropriately managed, and key problems are resolved. Yet beyond the assignment, the program does not provide additional structure; it is simply expected that each mentor-protégé pair manage the relationship based on their needs and style. While some participants value the advice and guidance on how to approach things, others value the vast network of experts the mentor introduces them to, others appreciate the exchange through question and answer sessions.

C. Assessment

To assess the value of the mentoring experience Phaeton maintains a wiki database that allows the program office to continuously measure the effectiveness of the partnership. The wiki functions as a repository: we track the number of times each participant meets with their mentor; collect qualitative data about the subject matter discussed; and record how participants applied the knowledge. The following are sample comments describing typical mentoring discussions:

- *"Discussed my dynamic analysis, including details of modeling, presence of the solar panel, and potential impact these may have on the final result. Overall, I feel more confident in my results and have a better idea of the additional analysis I need to do."*
- *"Discussed details of the image processing algorithm and its previous applications. It gave me a much better understanding of the technology we are using."*
- *"We discussed a particular requirement on the image data and what this means and if it can be verified."*

V. Training

Phaeton's approach to training is one that focuses on providing a varied and dynamic learning environment, incorporating the practice of blended learning. This technique is facilitated through the combination of different modes of delivery and models of teaching that occurs in and out of the training room. The program office incurs the cost of all training events, allowing participants to charge to a separate account for their time spent in training without straining the projects' budgets.

A. Formally Structured Training

Although the program was designed to be a channel for training via practice, experience, teamwork and delivery of a project, there are elements of any job that are best prepared through formally structured training. Such training is provided to ensure team members have the knowledge necessary to execute their project-related work and become educated on life beyond the program's realm. Conventional "classroom" instruction includes face-to-face sessions with subject matter experts, interview videos, tool tutorials, case studies, hands-on work, or war stories. This training has new weekly topics to ensure that the education from training courses is obtained and applied, strengthening both immediate and long-term retention. The topic is either selected by the Lead Technical Adviser or nominated as a topic of interest directly by the participants. (See Figure 3 in the Appendix for a list of topics covered in the training sessions.) All training course material, presentations, website links and contact information for subject matter experts reside in the program's wiki for on-demand access at any time. Attendance is mandatory for all participants and recorded on the wiki.

B. Non-Conventional Training

Structured training is also accompanied by a set of more non-conventional activities that occur outside the classroom. The intent is to deliver instruction in a way that will help participants understand the inherently complex processes of projects. The training events that do have a limited capacity for attendance require that the program administer a lottery for a random selection of participants. . Training activities include the following elements:

- *Project Reviews of the center's more advanced missions*
- *Tours of key Lab facilities*
- *Observation of key functions*
- *Reviews of Phaeton projects*
- *Field trips*
- *Special engagements in JPL's launches*
- *Conferences*

C. Assessment

Finally, the relevance and effectiveness of all training is measured via a weekly web-based evaluation that is emailed to all participants. The evaluations collect both qualitative and quantitative data, which is then posted on the wiki and presented at monthly management reviews to allow for transparency. The evaluations help determine if the subject matter expert was a right fit, if the information had the right level of detail, if the training increased knowledge of a topic, and other key elements that help determine if the particular training session was effective. The evaluations allow us to measure the outcome of the sessions, improve future training, and contribute to better design

of the training for future Phaeton groups. The feedback attained from the evaluations has been incredibly valuable in the continuous refinement of the structure of our training.

VI. Funding challenges

Like any program or project the work comes with its set of funding challenges, and the nature of Phaeton makes these sets of challenges a bit more unique. This section will discuss challenges, lessons learned, and potential resolutions.

A. Burden funding

Phaeton is funded by internal (burden) funding, such as the institutional training budget, which cannot be carried over to the next fiscal year. This has an interesting consequence for the projects. The project not only has to hit their overall project budget, but also hit a budget for each fiscal year. This consequence is specifically difficult when a high cost task is scheduled near the end of the fiscal year, and any slip in the schedule will cause the project to under-run the current fiscal year and start with an overrun in the second fiscal year, requiring a de-scope or request for additional funding.

One way to mitigate the risk of overruns and under-runs is to ensure the program has multiple projects that can exchange funds to help balance cost over fiscal year boundaries. For example, if one project under-runs due to a schedule slip, another project with an accelerated schedule can be cleared to overrun and the projects will exchange the increase for the reduction the following fiscal year.

B. Reserves and Funding Levels

The Lab provides fully funded reserves for the Phaeton's projects. This funding component is key to reducing risks to the project while also allowing the participants to learn proper procedures and processes that may be outside customary funding practices. It's important to consider that over-funded projects may not experience the same challenges that other institutional projects could encounter l and cause the participants to rely on wasteful spending behaviors. However, poorly-funded projects can create high risk to a project, which can lead to excessive unpaid overtime and condition the participants to bypass institutional processes. Finding appropriate funding levels is a key challenge. Phaeton may be able to mitigate this challenge by allowing the program and projects to hold their own reserves or allow the project to freely de-scope and take on more risk. These potential solutions are yet to be implemented and are being carefully considered to ensure that the consequences of taking any such action are fully understood.

C. Training budget

Training is a requirement of the program. However, if there are no requirements for training at the project level, training cost is one of the first items to be de-scoped as soon as the project budget is challenged.

The Phaeton program is solving this challenge by, (1) holding the training budget at the Program level, which is the case for the PMD project, and/or (2) having a specific requirement for training at the project level, which is the case for the TRaiNED project. Either way, the projects are aware of the workforce commitment to training and the impact of training to the project schedule. It is important to note that the fluctuating hours per week dedicated to training can provide persistent challenges to the projects in their efforts to properly plan the budget, workforce, and schedule. Despite these roadblocks the training portion of the program is crucial to its success.

D. Workforce

Typically, participants devote at least 50% and at most 75% of their time to their Phaeton project. The idea behind this structure is founded on the premise that participants do not lose touch with their group and the standard tasks of their line organization. This also allows for the program to accept more participants and afford others with the opportunity of participating in the program. However, in this first year of inception the demands of the projects have proven on occasion to require much more than 50%-75% of participants' time, thus making the workforce levels another challenge to cope with.

The time each participant dedicates to the project is split between training, team meetings, dry runs, reviews, mentoring, observing the reviews of the other projects and direct work on the project itself. This schedule is accentuated for the project managers who are also half time on the project. In addition to the tasks that a normal participant faces, the project managers attend weekly program staff meetings, meet weekly with their scheduler and project resource analysts and hold individual meetings with each participant, which the lab traditionally refers to as 'quiet hours'. This illustrates the challenge of managing the general workload of the project within the allocated

time. Due to these concerns Phaeton is looking at the possibility of allowing key roles such as the project manager and systems engineer be full time on the project.

The most unique characteristic of the program is its age demographic. The mix of youth and inexperience create difficulty in forecasting learning curves, task completion, and project delivery. The program has tried to mitigate this inexperience with qualified mentors who understand the scope of the work desired. The program will try to avoid these hurdles on OPALS by having a senior project manager lead the project and will fund an ECH as the deputy project manager at least 75% time. Mentors will also take a more proactive role in the structuring of the project and the program is also considering key systems roles to take on a full-time role.

E. Project priority

Phaeton's projects are considered non-mission critical flight instruments. The low priority standing of our projects has a significant impact upon budget and schedule due to the manner in which the JPL manufacturing process operates. In practice, manufacturing does not function on a 'first come first serve' basis but rather focuses on the Lab's major priorities. Thus, Phaeton projects wait until there is an opening in the manufacturing schedule. This can result in two situations: 1) either pay for a standing army as parts are delayed, or 2) pay overtime to the manufacturing organizations in order to get the parts delivered on schedule. The first option has a significant impact on project schedule, while the second option impacts the project's budget. The mitigation is to provide funded schedule reserve held by the project.

VII. Future of the Program

The following section presents the areas in which efforts will be made in further developing the future of the program. The experience and feedback point to areas of improvement. The success of Phaeton's projects will be a key factor in the long-term sustainability of the program. This is ultimately a training program; however, project failure at JPL is not an option and will be the key determining factor in the program's future. It is crucial that programmatic success is focused on training ECHs at JPL with projects serving as important goals of the program.

A. Educational Outreach

The program design and approach makes it so that there are 14-50 active participants at any one time. Yet, JPL has an estimated 400 designated ECHs, which challenges the program to include non-Phaeton ECHs in training. Presently, the program hosts career guidance lunches where a senior employee is invited to speak about their career at the Lab and give advice to the ECH audience. Forty ECHs are invited each month to the event. The program is searching for additional ways to engage the ECH community through learning opportunities. These Lab-wide events also serve to market Phaeton to other ECHs.

B. Program Graduates

The program makes every effort to allow the participant to stay on a project far into the project's life cycle. As each participant reaches the end of their tour of duty, the participant works for ~1 month in tandem with their Phaeton role replacement to gradually hand off ownership. This transition period requires that the new participant become familiar with the day-to-day work of basic procedures and issues. Additionally, the outgoing participant must update and share all documentation reflecting the development, activities, and current status of each task. Personnel transitions have occurred relatively smoothly by following this process.

As Phaeton continues to develop and expand the support, feedback and advice from alumni will be key to building upon the programs strengths and limitations. Alumni will chiefly provide guidance in how maximize the program's value and caution against some expected challenges. Additionally, the program will use current documented products as templates or reference for future participants. For example, the current participants are completing the gate product documents by tailoring examples from other extensive projects at JPL. A good amount of time was spent on vetting what was helpful given the limited scope of Phaeton's projects. We expect that the sharing of documents will make the learning curve shorter and allow more time to be spent on writing and creating the required documents.

C. Line management support

The support of supervisors is very important for the future of the program. One of the current challenges is communicating the value of the program to some of the participants' supervisors. Lack of support from a participant's supervisor can impact a project. If not handled correctly a supervisor may pull a participant away from Phaeton, causing schedule impacts. Some supervisors seem to prefer for their ECHs to be on the project for a 6-

month time frame instead of the full 18 months because they feel it's a sufficient length of time to be dedicated to training. In some cases this is sufficient. However, the program is intended to provide ECHs with exposure to the full life cycle of a flight project, making the accelerated lifecycle of 18 months a key component of the program. Therefore it is important to communicate with the supervisors and explain Phaeton is more than just a training class but rather an opportunity to gain key experience while still contributing to science and technology. To accomplish this the program will take the necessary steps to engage the supervisors early on in the project's lifecycle and establish a clear set of expectations.

VIII. Conclusion

Phaeton provides an opportunity to train and develop ECHs while simultaneously allowing each to contribute to a meaningful project early in their careers. Additionally, the program provides a mechanism for new hires to connect with experienced personnel and with each other, building the organization's internal network. This is a great benefit to both the participants and the institution. JPL has taken advantage of the desire to learn and turned it into a novel training program in which training goes beyond the conventional definition customary for organizations. The ECHs entering the workforce are eager to put to practice the ample knowledge gained through school and if we don't fulfill their profound desire then they'll simply look for it elsewhere. While many organizations anxiously await the talent of the future, JPL is molding tomorrow's talent by ensuring the wisdom of experienced personnel is shared and not lost.

Appendix

Figure 3. Training topics completed:

1. Project Planning
2. Acquisition process
3. Flight Project Practices and Design
4. Project Planning
5. Electrostatic Discharge Control
6. Critical Item Handling
7. Export Compliance
8. Dynamic Object Oriented Requirements System
9. Risk identification/management
10. Electrical Computer Aided Engineering
11. Friendly Front End Application
12. Work Agreements
13. Margins
14. Space Environment
15. Verification and Validation Requirements
16. Deep Space Network
17. Proposal and formulation
18. Product & Circuit Reliability
19. Electrical Grounding
20. NX Interface & SolidWorks
21. Space Interactions
22. Flight Software
23. Systems Engineering
24. Manufacturing process
25. Integration & Test
26. Circuit Data Sheets
27. Problem/Failure Reporting
28. Configuration Management
29. Trajectory and Navigation Design
30. Technical Writing
31. Presentation Skills
32. Engineering Technical Authority

Acknowledgments

Special thanks to Johnny Kwok for his ongoing guidance and vision to see this paper through to completion.

The work described in this publication was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

References

[1] McCann, Mike, "Workforce Information Cubes for NASA," [Online Database], URL: http://wicn.nssc.nasa.gov/generic.html [cited 02 Jul 2008]

[2] Space 2008 paper Richard R. Rieber, Thomas Coffee, Shuonan Dong, Samantha I. Infeld, Kendra B. Kilbride, Michael A. Seibert, and Benjamin S. Solish, "Bridging the Generation Gap: A Rapid Early Career Hire Training Program": AIAA Space 2008