Growing a Training System and Culture for the Ares I Upper Stage Project

David W. Scott
National Aeronautics and Space Administration
Marshall Space Flight Center, EO20
Huntsville, AL 35812
256-544-3226
Scotty@nasa.gov

Abstract—In roughly two years' time, Marshall Space Flight Center's (MSFC) Mission Operations Laboratory (MOL) has incubated a personnel training and certification program for about 1000 learners and multiple phases of the Ares I Upper Stage (US) project. Previous MOL-developed training programs focused on about 100 learners with a focus on operations, and had enough full-time training staff to develop courseware and provide training administration. This paper discusses 1) the basics of MOL's training philosophy, 2) how creation of a broad, structured training program unfolded as feedback from more narrowly defined tasks, 3) how training philosophy, development methods, and administration are being simplified and tailored so that many Upper Stage organizations can "grow their own" training yet maintain consistency, accountability, and traceability across the project, 4) interfacing with the production contractor's training system and staff, and 5) reaping training value from existing materials and events. [1,2]

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INTRODUCTION

For the International Space Station (ISS) program, MOL, a component of MSFC's Engineering Directorate, was and is tasked with managing NASA payload operations and related training. This includes providing payload training for flight crew at Johnson Space Center (JSC), basic console operations training for NASA payload developer teams distributed throughout the world, and basic and detailed console operationss training for civil service and contractor personnel working at the Payload Operations Integration Center (POIC) at Marshall. We've established some resident payload training staff at JSC, primarily for astronaut training, and worked with several outside organizations and space agencies. Due to both tradition and the intrinsic nature of operations, training was and is readily accepted and expected as part of the operations culture, and was included in program budgets and plans early on. Budget and redesign issues pushed ISS launch back several years, providing more time to develop the operations training program. Also, experience gained from Spacelab training in the 1980s and 1990s was brought to bear, and many of the learners for ISS had Spacelab operations experience.

In contrast, MOL was asked to help with training for the Ares I Upper Stage Project (US) <u>development</u> team after the development effort had begun. While the Spacelab and ISS operations populations and organizations were homogeneous and relatively small, about 100 learners at first, the US organization is diverse and large, approximately 1000 learners. To maintain good checks and balances, most sub-teams or disciplines within the US team have a project lead from the Upper Stage Office (USO) in MSFC's Project Office and an engineering lead from a discipline-related branch or division in MSFC'S Engineering Directorate. The engineering lead serves as Product Lead for the associated Integrated Product Team (IPT), and IPT members come from a plethora of organizations within NASA. At this writing, corresponding leads from the Production Contractor (PC) are being designated and added to the org chart. Generally speaking, NASA is not responsible for training PC personnel and vise versa, though there may be some overlaps, and it would be wise to make certain there are no underlaps.

Note – For this paper, "NASA" refers to civil servants and support contractor personnel working directly for NASA to design the US. "Production Contractor" refers to Boeing and its subcontractors working directly to build and deliver the US.

MISSION OPERATIONS LABORATORY TRAINING PHILOSOPHY

The following principles are based on training industry practices and on MOL's Spacelab and ISS experiences.

Training is simply the imparting of knowledge and skills needed to perform a specific job. By definition, someone is

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qualified to do a job if they have the needed knowledge and skills, no matter how they acquired them. Certification is a formal process in which management acknowledges that a learner is qualified and authorizes them to do the job. It's possible to certify someone without training (we wouldn't require Mozart to study Composition 101), but training, "qual", and "cert" usually go hand-in-hand (most of us are a long way from being Mozart).

The more critical a job is or the more accountability, the higher the need for certification. Certifications often require renewal due to time passage or configuration changes, just as we renew our driver's license and/or upgrade our license to let us drive a different type of vehicle. The closer we get to system production or operations, the more important it is to certify the system, supporting facilities/capabilities, and the people who build and/or operate them.

MOL favors an Instructional Systems Design (ISD) type approach for building an effective training program. Pioneered by the U.S. Air Force, ISD approaches use systems engineering methods to a) identify training needs (and exclude non-needs), b) negotiate compromises among training needs, time, money, and other resources, and c) establish training administration, provide training, gather feedback, maintain the system and products.

The front end of an ISD process – deciding what knowledge and skills need to be imparted -works like this: [1]

• Perform functional decomposition to break down Jobs into Duties, Tasks, Sub-Tasks, and Steps. Task statements are brief – an action verb followed by a noun – and do not overlap with other tasks. They should not define goals, attitudes, personal characteristics, knowledge, selection criteria, or be too detailed.

• Analyze Learners, especially how many to train, education, job experience, attitude/motivation. Both group and individual learner analyses are useful.

• Define Training Objectives, Performance Tests, and Goals for Post-Course Follow-up.

Course definition, design, and implementation are influenced by considering four basic training strategies, their major benefits, and selection criteria. See Figure 1.

JOB AIDS
Learning tool doubles as a work companion

ON-THE-JOB TRAINING
There's no experience like experience

SELF-PACED INSTRUCTION
Ex: Workbooks, Computer-Based Training (CBT)
Easy to schedule!

GROUP INSTRUCTION
Opportunities for team building and shared experience.

CRITERIA	STRATEGIES			
TIME	JOB AIDS	OJT	SP/CBT	GROUP
Shortage of training time	•	•	•	
Shortage of design time	•	•		
Infrequently performed task	•			
Task performance time is flexible	•	•		
Training difficult to schedule	•	•	•	
ECONOMIC	JOB AIDS	OJT	SP/CBT	GROUP
Number of learners				
High	•		•	
Medium				•
Low		•		
Learners spread geographically	•		•	
Heavy, expensive equipment needed		•	•	
Content is stable			•	•
Positive cost-benefit	•	•	•	•
INSTRUCTIONAL DESIGN	JOB AIDS	OJT	SP/CBT	GROUP
Complex task	•		•	
Shortage of instructors	•	•	•	
Safety is a concern		•		•
Much information needed	•			•
Varied learner background		•	•	
Valid performance test possible	•	•	•	•
ADMINISTRATIVE	JOB AIDS	OJT	SP/CBT	GROUP
Irregular Training load	•	•	•	
Standardization needed	•		•	
Record of results needed			•	
Employee turnover is high	•	•	•	
MOTIVATIONAL	JOB AIDS	OJT	SP/CBT	GROUP
Consequence of error is severe	•	•		
Training compatible with work flow	•	•		
Realism	•	•		
Managers enthusiastic about learning		•		
Learners poorly motivated	•	•		©Langevin Learning Services

Figure 1 – The Four Training Strategies and When They're Effective [2]

After or in conjunction with strategy selection, we can choose specific delivery methods. Within the training industry, there are approximately 50 methods, such as workbooks, lectures, simulations, internships, etc. Many are variations on a theme. Fortunately, they all fit into one of the four strategies, and it's certainly OK to use more than one method and/or strategy to address a particular need.

The important thing is to consciously select or even invent methods in an organized way, rather than pulling them out of thin air because that's what we (or someone else) used in some other situation.

Some training needs elude functional decomposition. In these cases, establishing a rich learning environment based on what _is_ known allows content (and sometimes requirements) to surface as discovery. A classic example of this is whole-team training exercises using realistic simulators of flight equipment with flightlike telemetry/commanding data streams flowing to/from actual control rooms. In addition to practicing known procedures, flight crew and ground controllers can be put into situations that let them (well, actually force them to) experience the process of working through unanticipated scenarios. This also builds team identity and that intangible "feel" for things, and sometimes the results of a sim lead to improvements in ground and flight procedures or policies. Both the Spacelab and ISS programs reaped huge benefits from this.

We won't go into the details of course development and delivery, training administration, and feedback in this paper. Instead, we'll end this section with three nuances that are absolutely critical for the success of any training program:

1. **We remember what we _do_ far better than what we merely see, read, or hear**. Adult learners prefer activity over academics, and bring a wealth of outside experience into the learning environment, especially in space programs. Because of this, **a healthy mix for training delivery is 35% presentation, 65% application and feedback.**

2. **Courses need to be tailored to both the task and the learners being trained.** Some courseware can be used for multiple learner populations, but don't teach folks how to build a clock if their task only involves telling time.

2. **Instructors need teaching skills as much or more than technical expertise.** A proficient instructor will ferret out needed material from lesson plans and/or Subject Matter Experts (SME) and engage learners. An SME who doesn't know how to teach will bore learners, who will learn and retain very little. (Have you ever died inside while the "pro" read word charts that looked like a thesis?) If an SME is going to teach, investing in instructor training pays off twice – classes are more successful, and the SME's other presentations, interactions, and results improve.

Enough philosophy already - let's build a rocket!

OVERVIEW - ARES I AND UPPER STAGE

To set the stage for exploring Upper Stage design and manufacturing training, let's take a high-level look at the source of the training needs. The Ares I vehicle is an in-line, two-stage rocket topped by the Orion crew vehicle and its launch abort system. Early missions will carry 4 to 6 astronauts to ISS beginning in 2015. At launch, the first-stage solid booster propels the vehicle. In mid-flight, the reusable booster separates and the liquid-fueled upper stage's J-2X engine ignites to finish putting the vehicle into low Earth orbit. (The J-2X was derived from the J-2 engines used in the Saturn V's 2nd and 3rd stages.).

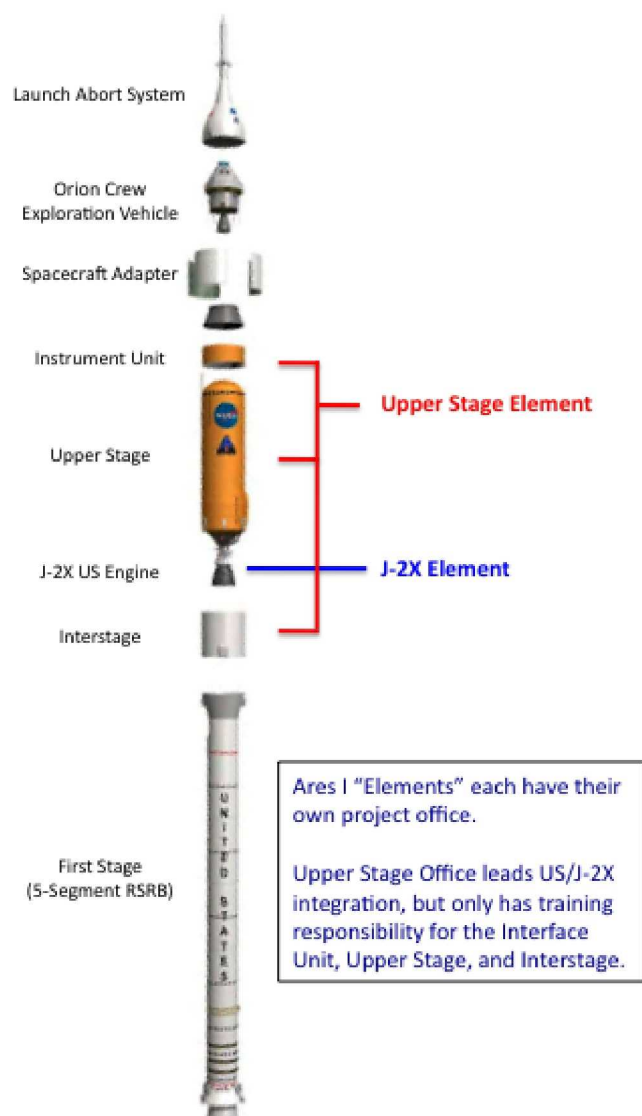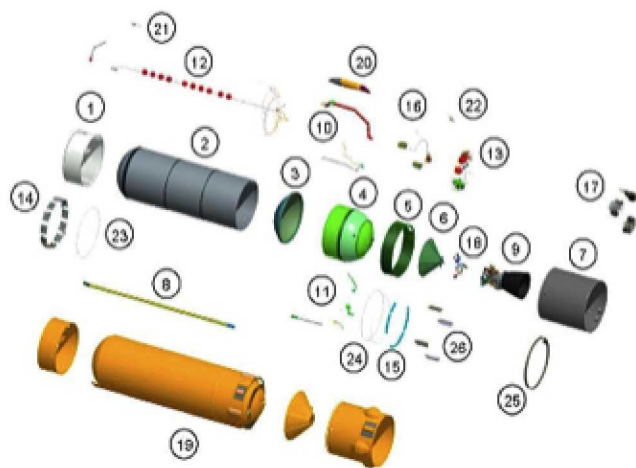Figures 2 and 3 show the major components of Ares I and the Upper Stage Element/Project, respectively. [3]

Figure 2 – Ares I Overview

1	Instrument Unit (IU)	14	IU Avionics
2	Liquid H2 Tank	15	Aft Skirt Avionics
3	Common Bulkhead	16	US Reaction Control System
4	Liquid O2 Tank	17	1st Stage Roll Control System
5	Aft Skirt	18	Thrust Vector Control
6	Thrust Cone	19	Thermal Protection System
7	Interstage	20	LH2 Feedline Fairing
8	System Tunnel	21	IU Umbilical Panel
9	US Engine	22	Aft Skirt Umbilical Panels
10	LH2 System	23	IU Purge & HGDS
11	LO2 System	24	Aft Skirt Purge & HGDS
12	Cryo Pressurization & Pneumatic Sys	25	Interstage Purge System
13	Ambient Press & Pneumatic System	26	Ullage Settling Motors

Figure 3 – Upper Stage Components

EVOLUTION OF UPPER STAGE TRAINING

The Upper Stage Office (USO) oversees training for the US project but does not have a formal background in training design or management. MOL's Training and Crew Support Branch (MOL Training) is scoped to assist with training as part of the US Integrated Logistics IPT, and has in-house experience in operations training development and delivery. MSFC's training office does not usually perform training development directly, but can fund and/or contract training development and has mechanisms for coordination and delivery of existing courseware.

Buildup of personnel for the US design effort had been accomplished by gathering folks from many disciplines, NASA organizations, and other projects. It quickly became apparent that there was little or no common understanding of fundamental Upper Stage hardware, software, and design philosophy and concepts. Logically enough, the USO asked MOL Training for help in developing and delivering a course to address the situation. MOL Training organized a 2-day "Upper Stage 101" training session for about 150 learners. Lead personnel and/or experts from each major discipline prepared and delivered overview presentations,

with some coaching from MOL Training on presentation techniques and on how to maintain reasonable consistency across presentations.

Positive response led to additional sessions for other learners within the US project and from other projects with a vested interest. To date, 12 sessions have been held, serving a total of 1060 learners, roughly 90% of whom are assigned to Upper Stage. The class is not "advertised" within the project or elsewhere, but managers keep requesting sessions, the sessions get bigger, and the number of learners from outside Upper Stage increases. A number of learners have stated that the 2-day class equates to 2 months of trying to glean information from the workaday environment. A number of learners and managers have expressed interest in having a similar course for the Ares I vehicle as a whole.

As the Upper Stage training concept matured and feedback came in from the steady stream of reviews and technical interchanges, it became evident that training needs within each subsystem, (e.g., how does one analyze, design, and build a Type X subsystem?) were minimal – people working within each discipline know and practice their trade well, as most of them have 5 or more years of experience. We found a very real need for more understanding across disciplines, because people are so well versed and entrenched in their specialty (and drenched in the documents and reviews coming their way) that it's difficult for them to pick out another subsystem's key point/issues (relative to their own specialty) from the documents and reviews drenching the other team.

"Upper Stage 102" courses, implemented as hyperlinked reference materials, strive to ease this problem by a) providing easy navigation through the most significant information about a given subsystem, typically drawn from 20 to 50 documents or other sources, and b) highlighting temporal information about current challenges and/or "bonus features" that may not have found their way into formal documents yet.

While collaborating on Upper Stage 101/102, a pictogram emerged that's been extremely useful in characterizing training needs, especially since time and manpower often didn't allow for the in-depth analysis of job functions, tasks, and the learner population. The result is shown in Figure 4. The titles of the vertical bars are the names of the Upper Stage subteams/disciplines/IPTs.

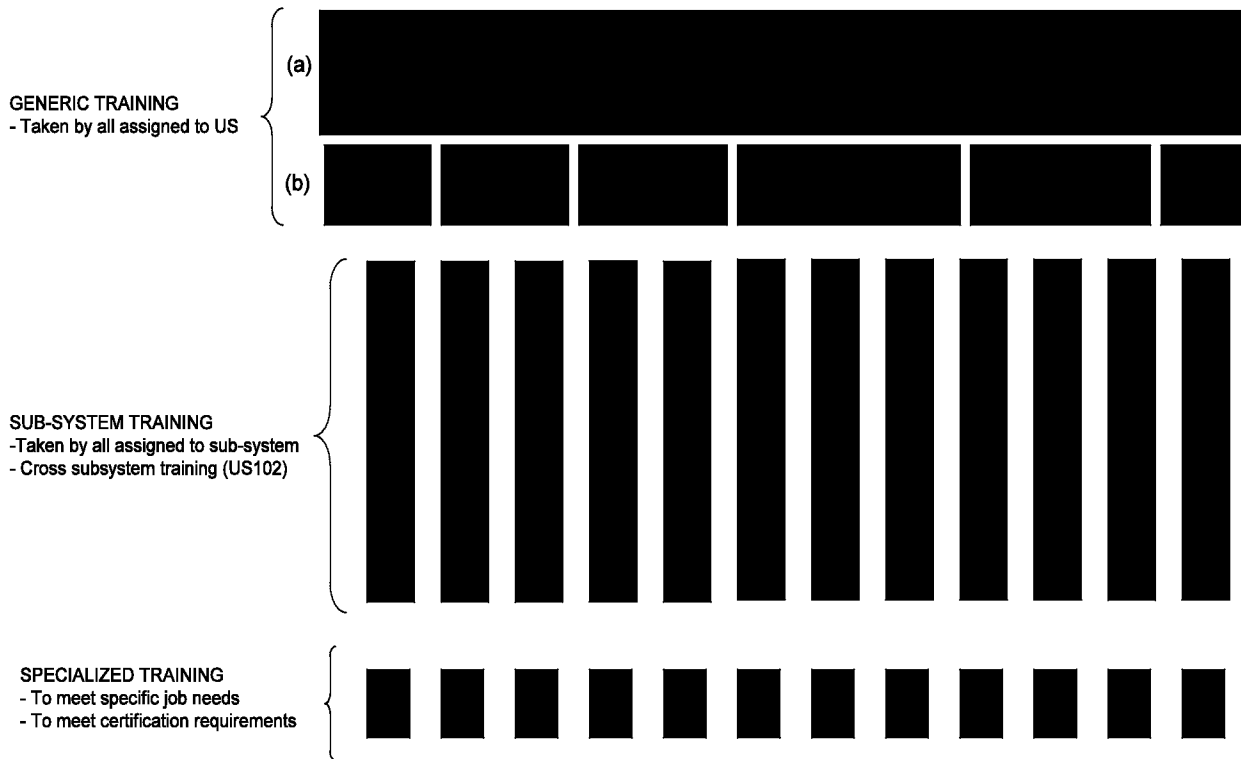## UPPER STAGE NASA Personnel Training

Figure 4 - Ares I Upper Stage Training - Partitioning [4]

For the 2007-2008 time frame, USO had tasked MOL Training to help define console ops/training requirements for a Test Control Room (TCR) at the Michoud Assembly Facility (MAF). (Facility schedules called for early design and build commitments.) A small, two-part epiphany erupted while working on a TCR training plan:

1. NASA will build the TCR, then deliver it to the Production Contractor, who will operate it. While NASA could deliver training media and/or instruction on systems it built, the Production Contractor needs to train/certify its own people on how to run the TCR itself. (This is sort of a mirror image of the manufacturer who supports the aircraft it sold to the military, but the military trains and certifies its own pilots.)

2. Other parts of the US Project could benefit from training plans, but there was as yet no US project-wide guidance on fundamental training and certification principles and requirements for consistency, accountability, and traceability. While these tend to evolve naturally as operations draws nearer, establishing them early would benefit the development effort and make for a smoother transition to operations, especially for a human-rated vehicle.

During the US Preliminary Design Review (PDR) in May/June 2008, MOL Training worked with USO and proposed a training architecture via an update to the Integrated Logistics Support Plan (ILSP). The architecture promotes consistency across the US program, aligns US training philosophy with fundamental training industry principles, defines appropriate authority levels and containers for various levels of detail, and even allows for training guidance for future projects.

UPPER STAGE TRAINING ARCHITECTURE

For the Upper Stage 101 and 102 courses, time and MOL Training manpower constraints have kept us from developing the activity-based training that we'd prefer. Thus far, existing NASA and/or commercial classes with an appropriate level of hands-on time have been able to cover needs for Specialized Training (see bottom of Figure 2).

With the timing and amount of training development funding unsure, we worked to define fundamental structure for the Upper Stage training program by partitioning documentation and responsibilities.

Documentation:
• Integrated Logistics Support Plan (ILSP) – Provides an executive view only.
• Upper Stage Personnel Training and Support Plan (Attachment to ILSP) – Explains basic approach to US training;, describes documentation, roles, and responsibilities; explains course development and acceptance process

• Subsystem Training Plans – Summarize training needs for personnel within each discipline, identify broad job performance requirements for positions
• Position Training Plans – Explain the details of performance requirements for each position, and suggested/preferred strategies/methods for training them.
• Individual Training Plans (ITP) – Each Upper Stage NASA learner will have a training plan (including certification criteria, if appropriate) tailored to the job(s) they will do and their abilities and needs. These will be based on the Position Training Plans
• MOL Training Systems Guide – Explains MOL training philosophy, strategies, and methods in significant detail, and includes examples of what has worked (and not worked) in past programs. Document is internal to MOL, i.e., not under the Ares I / Upper Stage umbrella, so that other programs need not reinvent the wheel.

Basic responsibilities are as follows:
• USO – Oversight of US training. Provide Generic Training and access to Specialized Training.
• MOL/MOL Training – Provide consulting and authoring services, primarily to USO and subteam management. Build templates ("blank books") and guidance from which customized training plans can be built by lower level teams.
• Subteam project and engineering management – Define high-level and mid-level training plans.
• Branch management of each NASA participant – Customize, implement, and provide training administration for each participant/ITP.

Figure 5 illustrates the relationships among documents and responsible organizations.
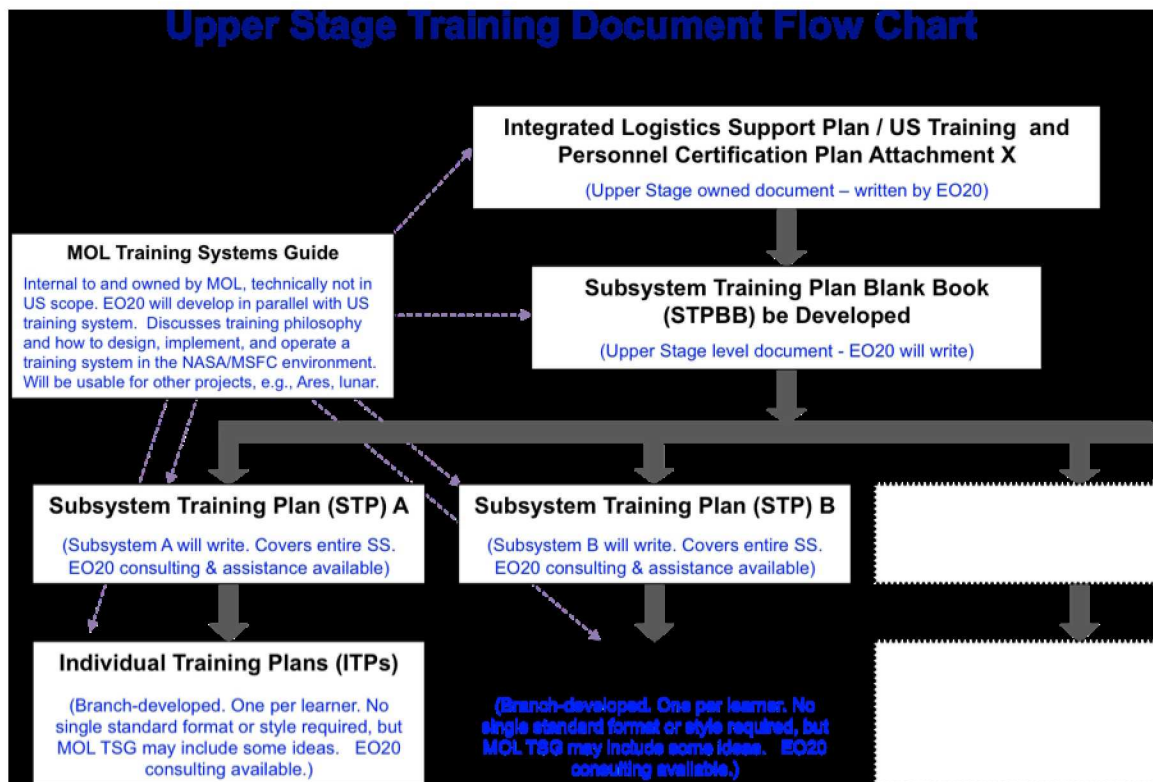

Upper Stage Training Document Flow Chart

Integrated Logistics Support Plan / US Training and Personnel Certification Plan Attachment X
(Upper Stage owned document – written by EO20)

MOL Training Systems Guide
Internal to and owned by MOL, technically not in US scope. EO20 will develop in parallel with US training system. Discusses training philosophy and how to design, implement, and operate a training system in the NASA/MSFC environment. Will be usable for other projects, e.g., Ares, lunar.

Subsystem Training Plan Blank Book (STPBB) be Developed
(Upper Stage level document - EO20 will write)

Subsystem Training Plan (STP) A
(Subsystem A will write. Covers entire SS. EO20 consulting & assistance available)

Subsystem Training Plan (STP) B
(Subsystem B will write. Covers entire SS. EO20 consulting & assistance available)

Individual Training Plans (ITPs)
(Branch-developed. One per learner. No single standard format or style required, but MOL TSG may include some ideas. EO20 consulting available.)

(Branch-developed. One per learner. No single standard format or style required, but MOL TSG may include some ideas. EO20 consulting available.)

Figure 5 – Training Document Ownership, Authorship, and Consulting

INTERFACE WITH PRODUCTION CONTRACTOR

NASA (including its support contractors) is designing Ares I and the Upper Stage, while the Production Contractor will actually build it. For the most part, each group will look after their own when it comes to training, thought there will obviously be some crossover. The situation is a little bit like building the transcontinental railroad: two entities are laying track, but they need to meet in the middle, and the tracks need to line up. During preliminary work with the Test Control Room team, MOL Training had some very preliminary discussions with the Production Contractor about gaining insight into each other's approaches and implementations of training. Knowing what to expect has tremendous value. We hope to devote more to this effort before the next round of design reviews begins.

SERENDIPITY - NO PAIN, MUCH GAIN

Training media and events often need to be conceived, designed and built, but even in these early stages of Upper Stage training program development, some existing assets with training value have dropped into our laps and deserve mention here:

- During the Manufacturing and Assembly (M&A) segment of an Upper Stage 101 session, the M&A instructor showed an 8-minute conceptual animation of the process for building and populating the US structure. You could almost see the light bulbs turning on in people's minds. The animation had been built for another purpose, but was matched perfectly to the "kick start" needs of the US 101 learner population.

- While building the US 102 class for M&A, the author from MOL Training learned of 2 or 3 very brief animations (less than one minute each) showing the essential ideas behind friction stir welding, which is a critical construction method for US. The increase in learner comprehension between reading about the process and seeing it illustrated dynamically is astounding. In some cases, animation makes the key ideas evident more readily than photography or video, due to both visual and time-lapse clarity.

- The section on MOL Training Philosophy mentioned the value of rich learning environments. The Ares I Flight Operations Working Group, jointly chaired by MSFC and JSC, realized that observing Mission Control Center's launch/ascent simulations for upcoming Shuttle missions could provide much insight into things we'll need to consider for Ares. (Each day of simulation involves multiple ascents, some nominal and others with malfunctions inserted by the sim team.) We've paid one such visit to JSC, found it most beneficial, and anticipate more to come. The benefit for operations developers is obvious, but just as -importantly, giving rocket engineers (hardware, software, engine, avionics, or other) a chance to see and, to some extent, vicariously experience the flight controllers' world, helps them <u>feel</u> the split-second nature of operations and provides motivation for making those products as robust and reliable as possible.

- Another vicarious experience was found in an electronic presentation of subtitled audio from an actual Shuttle launch, along with dynamic graphics showing which flight controllers were speaking on which voice loops.

CONCLUSION

Tell me....And I Forget,
Teach me.....And I Learn,
Involve Me.....And I Remember.
                    Benjamin Franklin

Even without a large training staff, the fundamental principles of Instructional Systems Development (ISD) can be applied to ensure well-targeted, effective use of whatever resources are available. By consulting with professional training personnel, organizations can do much if not most of their own training development. The 20-80 principle (20% of the effort needed to do a job completely provides 80% of the benefits) applies here, with the caveat that there should be no gaps in covering critical and/or safety items.

Animation or other forms of dynamic visualization are extremely well-suited for imparting central and/or difficult concepts. Their "Eureka!" value offsets the monetary cost.

Rich learning environments can compensate for situations where functional decomposition of jobs and tasks comes up short. In the early stages of a new project, exposure to the operations and/or simulation environment of similar, mature projects can provide tremendous insight for designers in all disciplines.

Keep a sharp eye out for existing materials inside our outside the training organization that can be brought to bear on training needs, but take the time to tune them for the audience if at all possible.

Effective training programs a) emphasize <u>doing</u> by the learners (healthy activity mix = 35% presentation, 65% application), b) tailor courseware to both the tasks and the learners being trained, and c) ensure that instructors have teaching skills as well as subject knowledge.

References

[1] Adapted from Langevin Learning Services, Training 101: All The Basics (Class Workbook), 1999.

[2] Adapted from Langevin Learning Services, Training 101: All The Basics (Class Workbook), 1999.

[3] Adapted from Marshall Space Flight Center, Ares I Upper Stage (US) Element Integrated Logistics Support Plan (ILSP), USO-CLV-LS-25401 PDR, 2008.
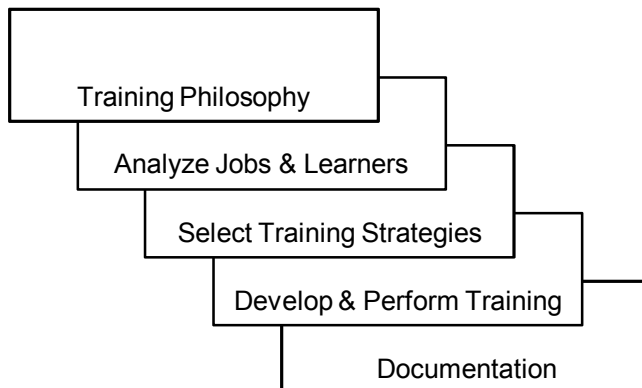
[4] Copied from Marshall Space Flight Center, Ares I Upper Stage (US) Element Integrated Logistics Support Plan (ILSP), USO-CLV-LS-25401 PDR, 2008

Biography
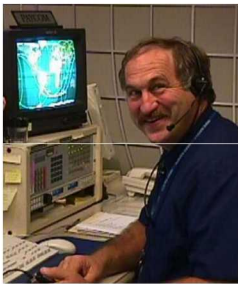
David W. Scott, alias "Scotty", is involved with operations and training development for NASA's next-generation ARES launch vehicles, and has been a Payload Communications Manager for the International Space Station since 1999. He's spearheaded several console technology projects, especially in space-to-ground videoconferencing and audio archiving. He was a payload communicator for the ATLAS-1 Spacelab mission in 1992, and helped design the payload training program for Space Station. He spent 6 years as a U.S. Naval Officer, including flight duty in F-14s, and holds a B.S. in Physics and Mathematics from Principia College.

Growing a Training System and Culture for the Ares I Upper Stage Project

Training Philosophy

Analyze Jobs & Learners

Select Training Strategies

Develop & Perform Training

Documentation

David W. Scott
NASA – MSFC EO20
256-544-3226

Where We'll Go

Mission Ops Lab (MOL) Training and Crew Ops Heritage

MOL Training Philosophy

Overview – Ares I and Upper Stage

Evolution of Upper Stage Training

Upper Stage Training Architecture

Capitalizing on "Freebies"

Wrap-Up

Training and Crew Ops Heritage at MSFC
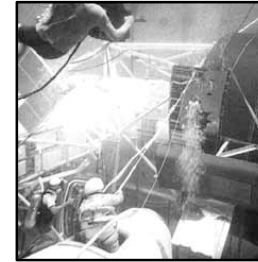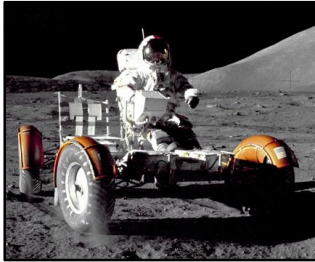
1960's – 1980's: Human Factors for Apollo, Skylab, Spacelab - Designed h/w, crew procedures
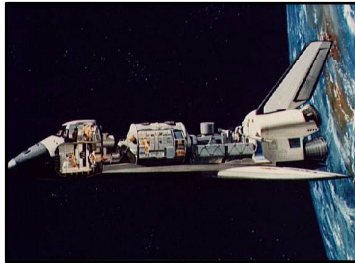
1980's – 1990's: Spacelab

   Trained payload crew, payload ops ground cadre, Principal Investigator teams – all at Huntsville
   Provided payload crew communicators (CAPCOM for payloads)
   Early missions at MCC Houston, most at Payload Ops Control Center at MSFC

1990's – Present: ISS

   Crew training at JSC, Cadre training and Payload Academy for PDs at MSFC
   Provide payload crew communicators (CAPCOM for payloads)

How Can We Avoid This?

Mission Ops Lab Training Philosophy

So What <u>Is</u> Training, Anyway?

The Performance Wheel

INCENTIVE/MOTIVATION · CAPACITY · STANDARDS · KNOWLEDGE AND SKILL · MEASUREMENT · FEEDBACK · CONDITIONS
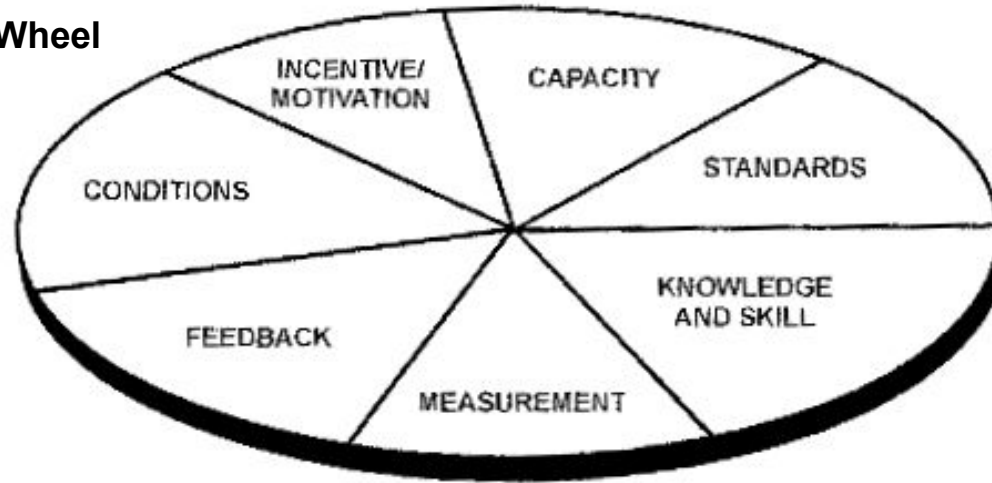
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- **Training = The delivery of knowledge and skills in order to perform a specific task.**

- **Trainer = The guide on the side, not the sage on the stage.**

(If the ingredient needed for success is not knowledge and skill, it needs to come from outside of the training environment.)

Adult Learners

- **Want Real-Life Content** – How to, not academics.

- **Are Active** – After ~20 minutes, need activity they can <u>do</u>.

- **Bring Experience** – Let them participate and contribute. Avoid long lectures, one-way communication.

- **Have Self-Esteem** – This is the big thing they can lose in training. It's crucial to provide a safe, welcoming environment that's not too directive.

To succeed with them:

- **Focus on <u>Results</u>** – Show them what will be gained, progress being made.

- **Aim at Here-and-Now** – Focus on current issues, tasks, and skills.

Learning Retention Rates
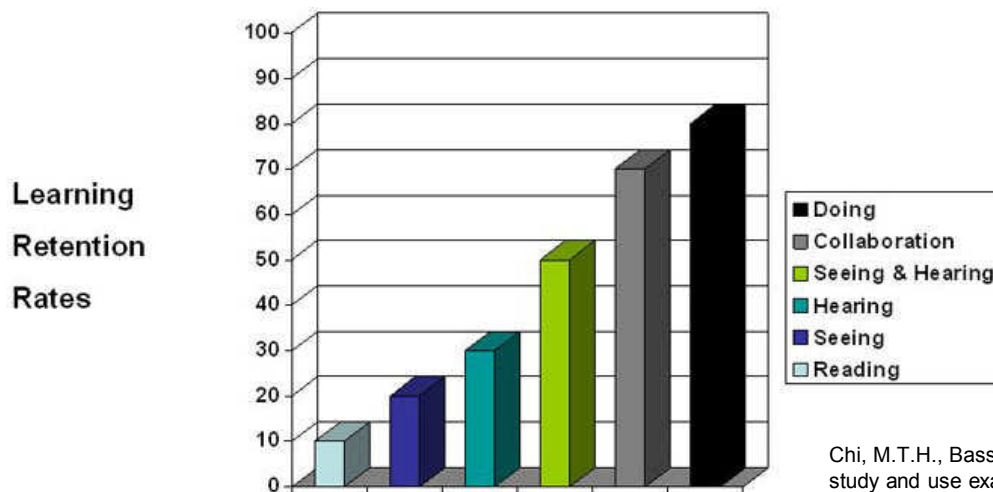
Chi, M.T.H., Bassok, M., Lewis, M. W., Reimann, P., & Glaser, R. (1989) Self-explanations: How stud study and use examples in learning to solve problems. Cognitive Science, Vol 13, Issue 2, pp. 145-18

The Importance of "How"

Learning Retention Rates

Legend:
- Doing
- Collaboration
- Seeing & Hearing
- Hearing
- Seeing
- Reading

Chi, M.T.H., Bassok, M., Lewis, M. W., Reimann, P., & Glaser, R. (1989) Self-explanations: How st
study and use examples in learning to solve problems. Cognitive Science, Vol 13, Issue 2, pp. 145-
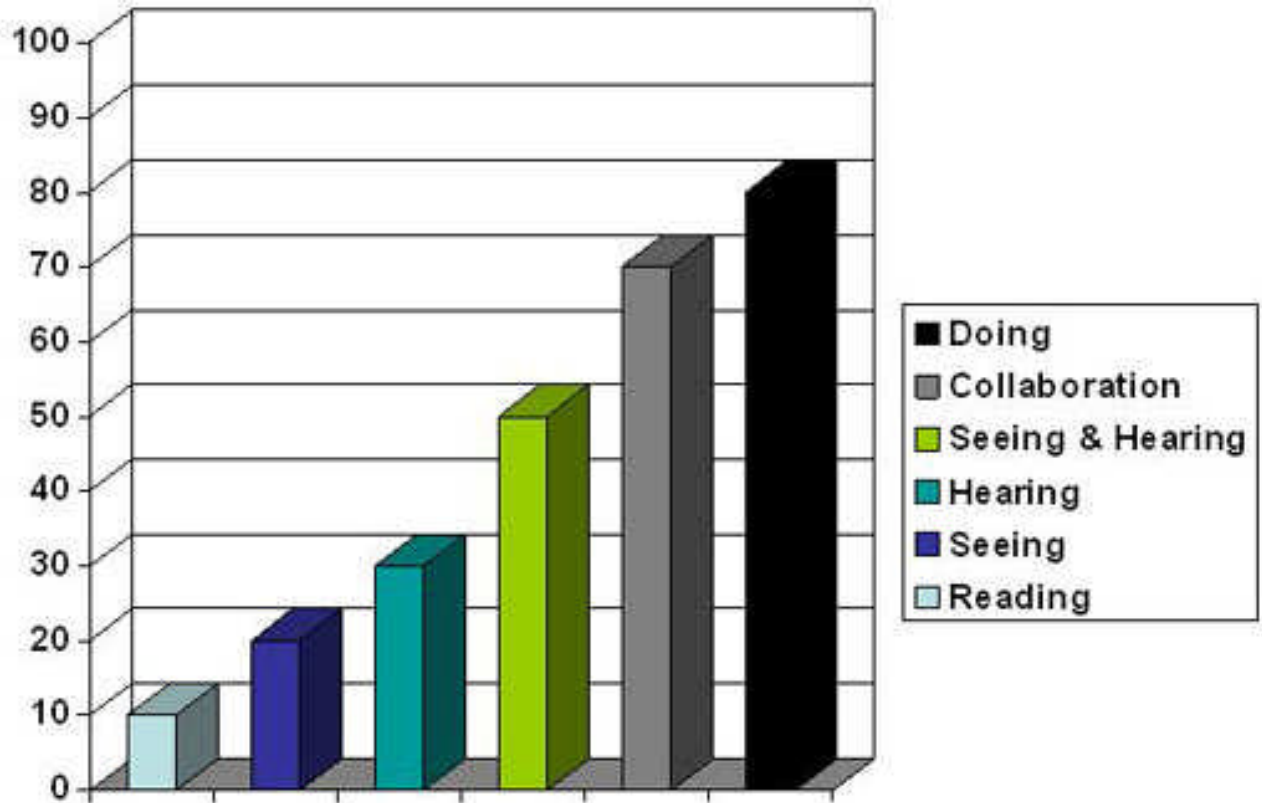
Training Analysis and Design

- **Instructional Systems Development (ISD)** – Uses System Engineering methods to analyze and develop training.

- **Analyze Jobs - Duties, Tasks, Sub-Tasks, and Steps** (Functional Decomposition)
    - Task statements – <u>Brief</u> - Action verb followed by a noun. Don't overlap with other tasks.
    - Task statements should not define goals, attitudes, personal characteristics, knowledge, selection criteria, or be too detailed.

- **Analyze Learners**
    - Especially how many to train, education, job experience, attitude/motivation

- **Define Training Objectives, Performance Tests, Post-Course Follow-up**

- **Select Training Strategies and Methods (Cost-Benefit Analysis)**

- **Prepare Individual Training Plan (ITP) for each learner** (either one for each job or one covering all jobs they'll do).

Training Strategy Selection

JOB AIDS
Learning tool doubles as a work companion

ON-THE-JOB TRAINING
There's no experience like experience

SELF-PACED INSTRUCTION
Ex: Workbooks, Computer-Based Training (CBT)
Easy to schedule!

GROUP INSTRUCTION
Opportunities for team building and shared experience.

CRITERIA	STRATEGIES			
TIME	**JOB AIDS**	**OJT**	**SP/CBT**	**GRO**
Shortage of training time	•	•	•	
Shortage of design time	•	•		
Infrequently performed task	•			
Task performance time is flexible	•	•		
Training difficult to schedule	•	•	•	
ECONOMIC	**JOB AIDS**	**OJT**	**SP/CBT**	**GROUP**
Number of learners				
High	•		•	
Medium				•
Low		•		
Learners spread geographically	•		•	
Heavy, expensive equipment needed		•	•	
Content is stable			•	•
Positive cost-benefit	•	•	•	•
INSTRUCTIONAL DESIGN	**JOB AIDS**	**OJT**	**SP/CBT**	**GROUP**
Complex task	•		•	
Shortage of instructors	•	•	•	
Safety is a concern		•		•
Much information needed	•			•
Varied learner background		•	•	
Valid performance test possible	•	•	•	•
ADMINISTRATIVE	**JOB AIDS**	**OJT**	**SP/CBT**	**GROUP**
Irregular Training load	•	•	•	
Standardization needed	•		•	
Record of results needed			•	
Employee turnover is high	•	•	•	
MOTIVATIONAL	**JOB AIDS**	**OJT**	**SP/CBT**	**GROUP**
Consequence of error is severe	•	•		
Training compatible with work flow	•	•		
Realism	•	•		
Managers enthusiastic about learning		•		
Learners poorly motivated	•	•		

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Functional Decomposition

Rich Environments

Job

Duty | Duty | Duty

Tas k | Tas k | Tas k | Tas k | Tas k

Sub-Task | Sub-Task | Sub-Task | Sub-Task | Sub-Task

Step | Step | Step | Step | Step | Step | Step

© Langevin Learning Services

Tools

Variables

Guidance (or not)

Learners

Flexible Goals

Situations

Questions/ Problems/ Opportunities

Three Chunks of Bedrock

Gisimaba Memorial Center

Emphasize <u>Doing</u>
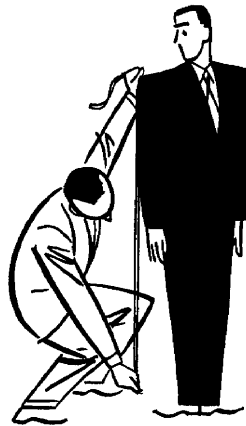
Tailor Training
to Task <u>and</u> Learner
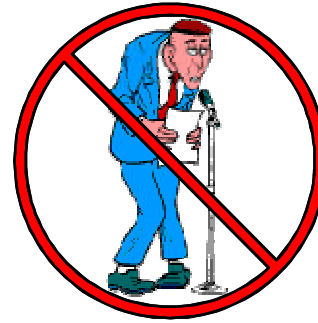
Teaching Skill ≥ Technical Skill

Presentation (35% of a healthy training mix)

Who's the star? Who should be?
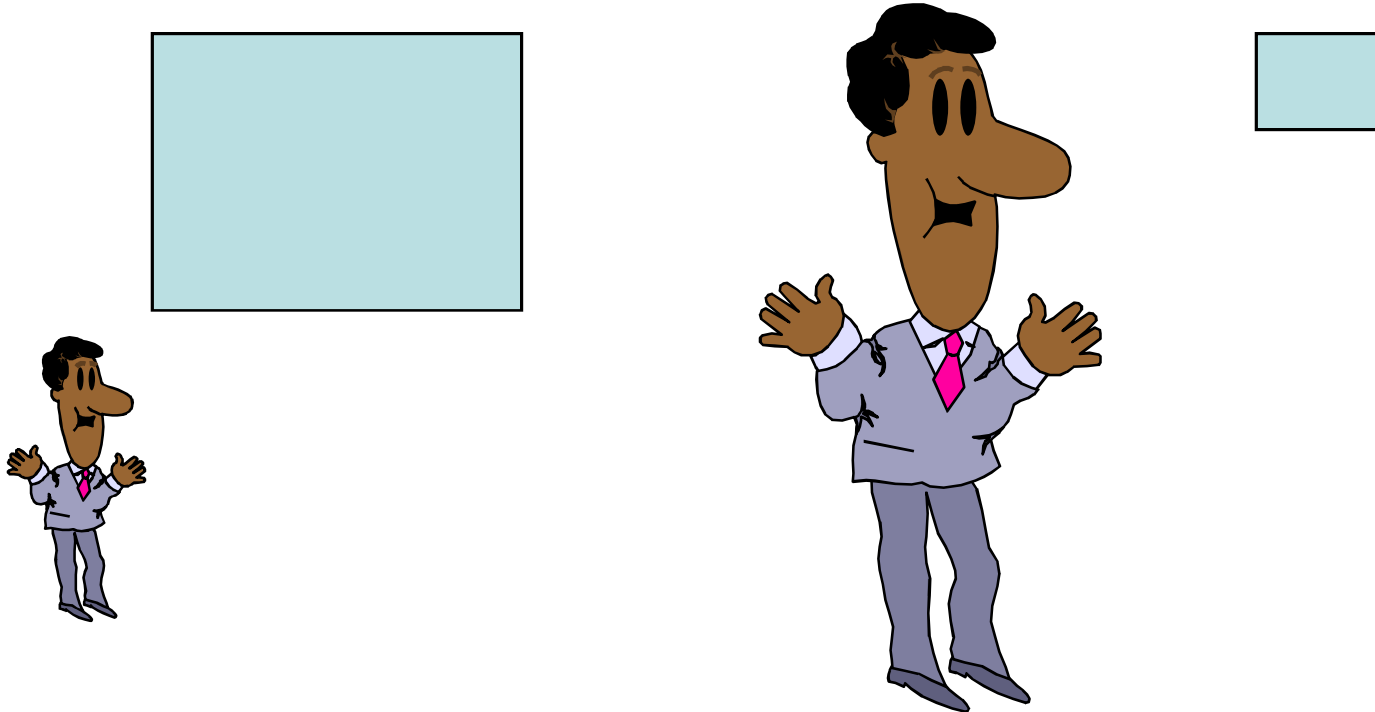
Don't hide behind charts. Keep the audience engaged.

P.S. They already know how to read!

Application (65% of a healthy training mix)

Where's the focus now? On the <u>learner!</u>

Enough of

. . . for now

Overview – Ares I and Upper Stage

Launch Abort System

Orion Crew Exploration Vehicle

Spacecraft Adapter

Instrument Unit

Upper Stage Element

Upper Stage

J-2X Element

J-2X US Engine

Interstage

First Stage (5-Segment RSRB)
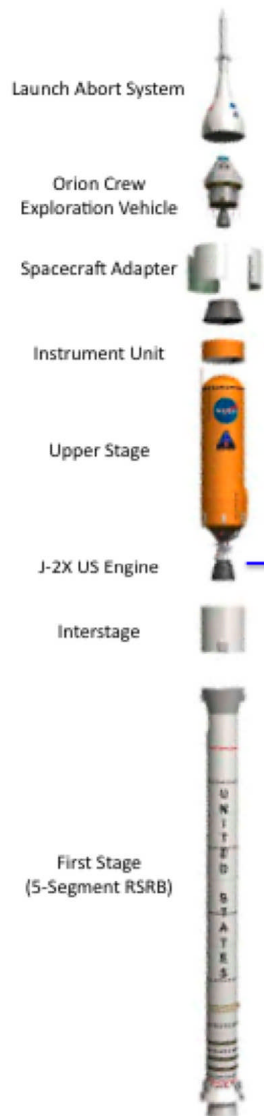
Ares I "Elements" each have their own project office.

Upper Stage Office leads US/J-2X integration, but only has training responsibility for the Interface Unit, Upper Stage, and Interstage.

#	Component	#	Component
1	Instrument Unit (IU)	14	IU Avionics
2	Liquid H2 Tank	15	Aft Skirt Avionics
3	Common Bulkhead	16	US Reaction Control System
4	Liquid O2 Tank	17	1st Stage Roll Control System
5	Aft Skirt	18	Thrust Vector Control
6	Thrust Cone	19	Thermal Protection System
7	Interstage	20	LH2 Feedline Fairing
8	System Tunnel	21	IU Umbilical Panel
9	US Engine	22	Aft Skirt Umbilical Panels
10	LH2 System	23	IU Purge & HGDS
11	LO2 System	24	Aft Skirt Purge & HGDS
12	Cryo Pressurization & Pneumatic Sys	25	Interstage Purge System
13	Ambient Press & Pneumatic System	26	Ullage Settling Motors

Evolution of Upper Stage Training

Three Definitions and a Challenge

- Training – Imparting of skills and knowledge needed to <u>do</u> a specific job.

- Qualified – Able to do the job, regardless of how skills/knowledge were learned

- Certified – Management acknowledges qual and authorizes person to do it.
  Higher job criticality or accountability -> higher need for certification

Project	Years to Develop Training Program	Initial Learners	Learner Orientation
ISS	10	100	Operations
Ares I US	2	1000	Design

[Note – An audience participation demo occurs after presenting this slide and before presenting next slide]

Upper Stage 101

- Nothing Fancy - 2 days of presentations by Integrated Product Team leads

- MOL provided some guidance on presenting

- Organized fairly quickly and at reasonable cost

- Feedback – Learned more in 2 days than from 2 months of reading/gleaning in the workaday environment

- To date: 12 sessions, 1060 learners (90% directly assigned to Ares)

- Management considering having MOL develop "Ares I 101"

Upper Stage Training – Partitioning

a.k.a. "The Piano Key Chart"
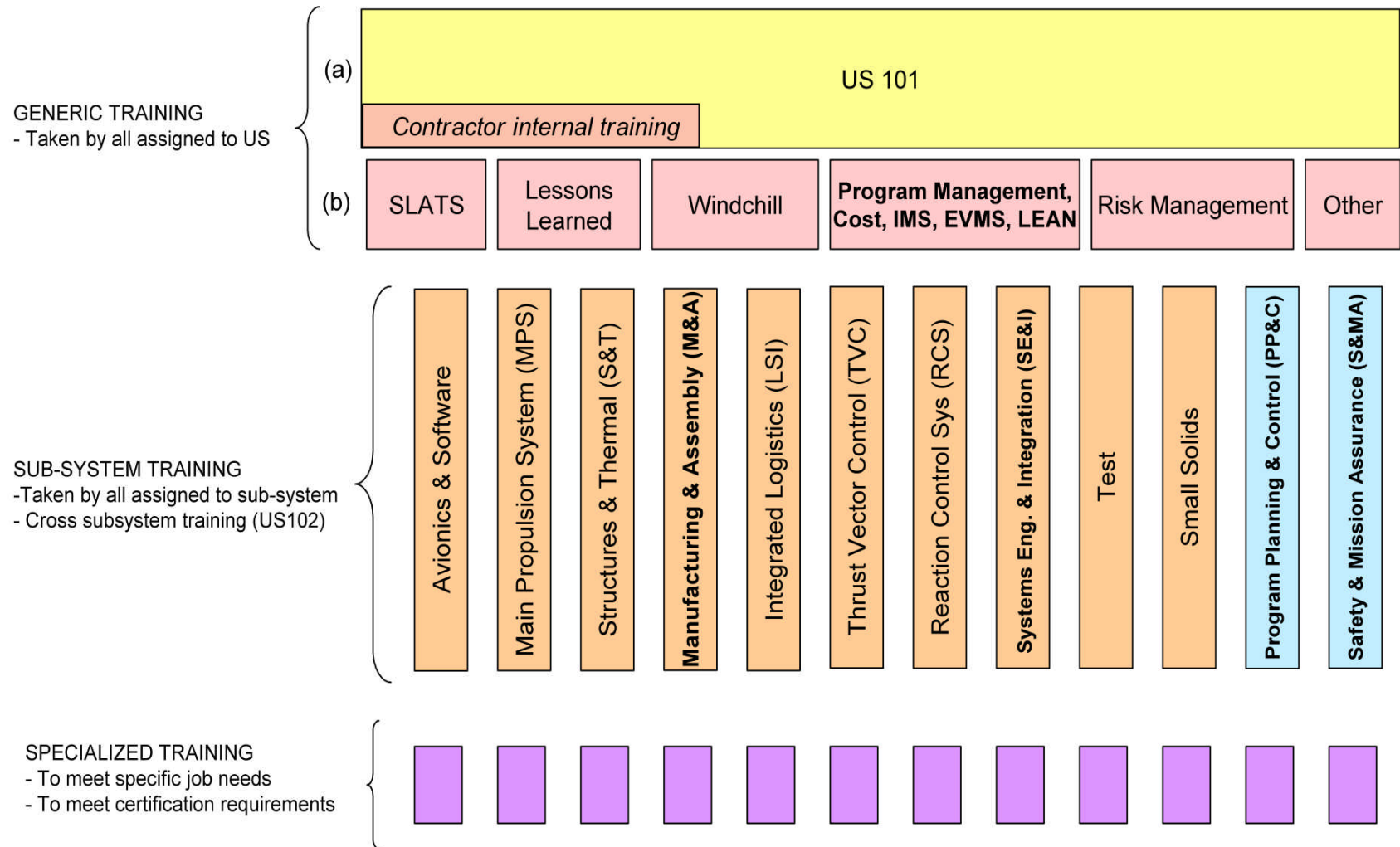
GENERIC TRAINING
- Taken by all assigned to US

(a) US 101

Contractor internal training

(b) SLATS | Lessons Learned | Windchill | **Program Management, Cost, IMS, EVMS, LEAN** | Risk Management | Other
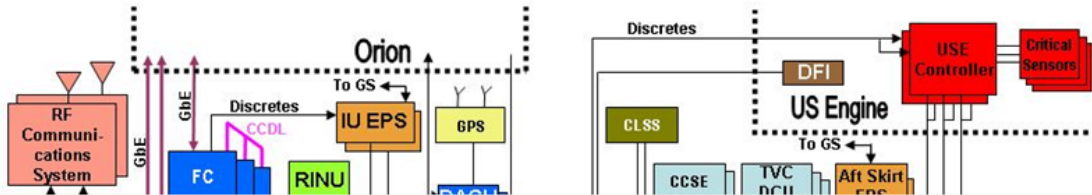
SUB-SYSTEM TRAINING
- Taken by all assigned to sub-system
- Cross subsystem training (US102)

- Avionics & Software
- Main Propulsion System (MPS)
- Structures & Thermal (S&T)
- **Manufacturing & Assembly (M&A)**
- Integrated Logistics (LSI)
- Thrust Vector Control (TVC)
- Reaction Control Sys (RCS)
- **Systems Eng. & Integration (SE&I)**
- Test
- Small Solids
- Program Planning & Control (PP&C)
- Safety & Mission Assurance (S&MA)

SPECIALIZED TRAINING
- To meet specific job needs
- To meet certification requirements

Upper Stage 102 Sample

Build by Leapfrogging!

Used Another
Opportunity for Input

Ares I
PDR

Generic Training and
Certification
Verbage

Proposed a Project-
Wide Approach

Upper
Stage
PDR

Integrated
Logistics
Volume

Attachment

High-Level
Architecture

Formal
Charter for
Training LOE

Test
Control
Room
Rqmts

April 2008 —————————————→ August 2008

Architecture

Upper Stage Training Document Flow Chart

Integrated Logistics Support Plan / US Training and Personnel Certification Plan Attachment X

(Upper Stage owned document – written by EO20)

Influence/Reference

MOL Training Systems Guide

Internal to and owned by MOL, technically not in US scope. EO20 will develop in parallel with US training system. Discusses training philosophy and how to design, implement, and operate a training system in the NASA/MSFC environment. Will be usable for other projects, e.g., Ares, lunar.

Subsystem Training Plan Blank Book (STPBB) be Developed

(Upper Stage level document - EO20 will write)

Subsystem Training Plan (STP) A

(Subsystem A will write. Covers entire SS. EO20 consulting & assistance available)

Subsystem Training Plan (STP) B

(Subsystem B will write. Covers entire SS. EO20 consulting & assistance available)

Individual Training Plans (ITPs)

(Branch-developed. One per learner. No single standard format or style required, but MOL TSG may include some ideas. EO20 consulting available.)

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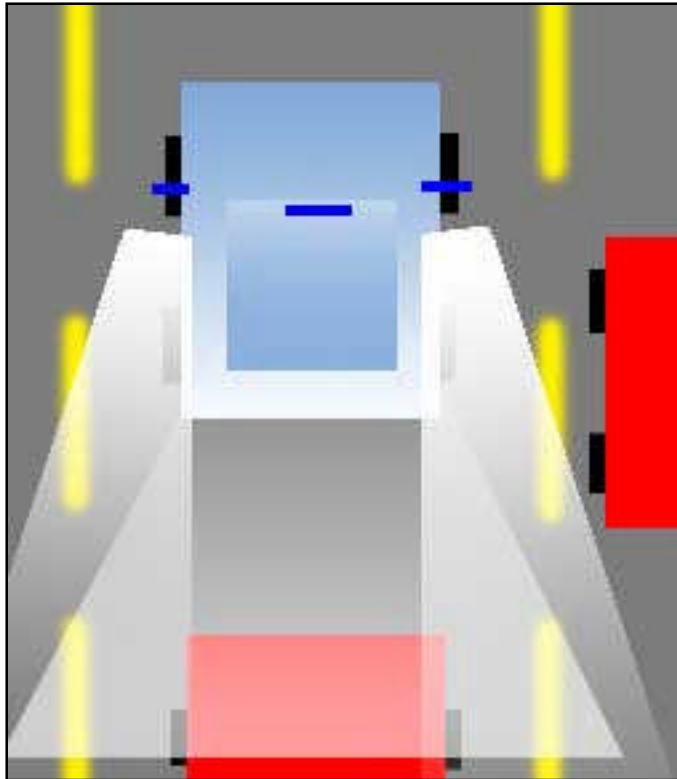
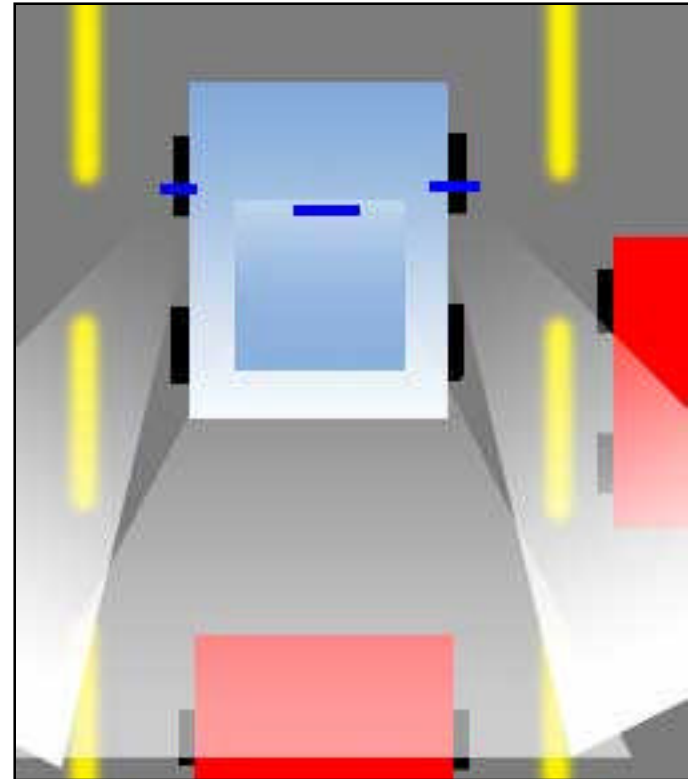# Serendipity: Media of Opportunity
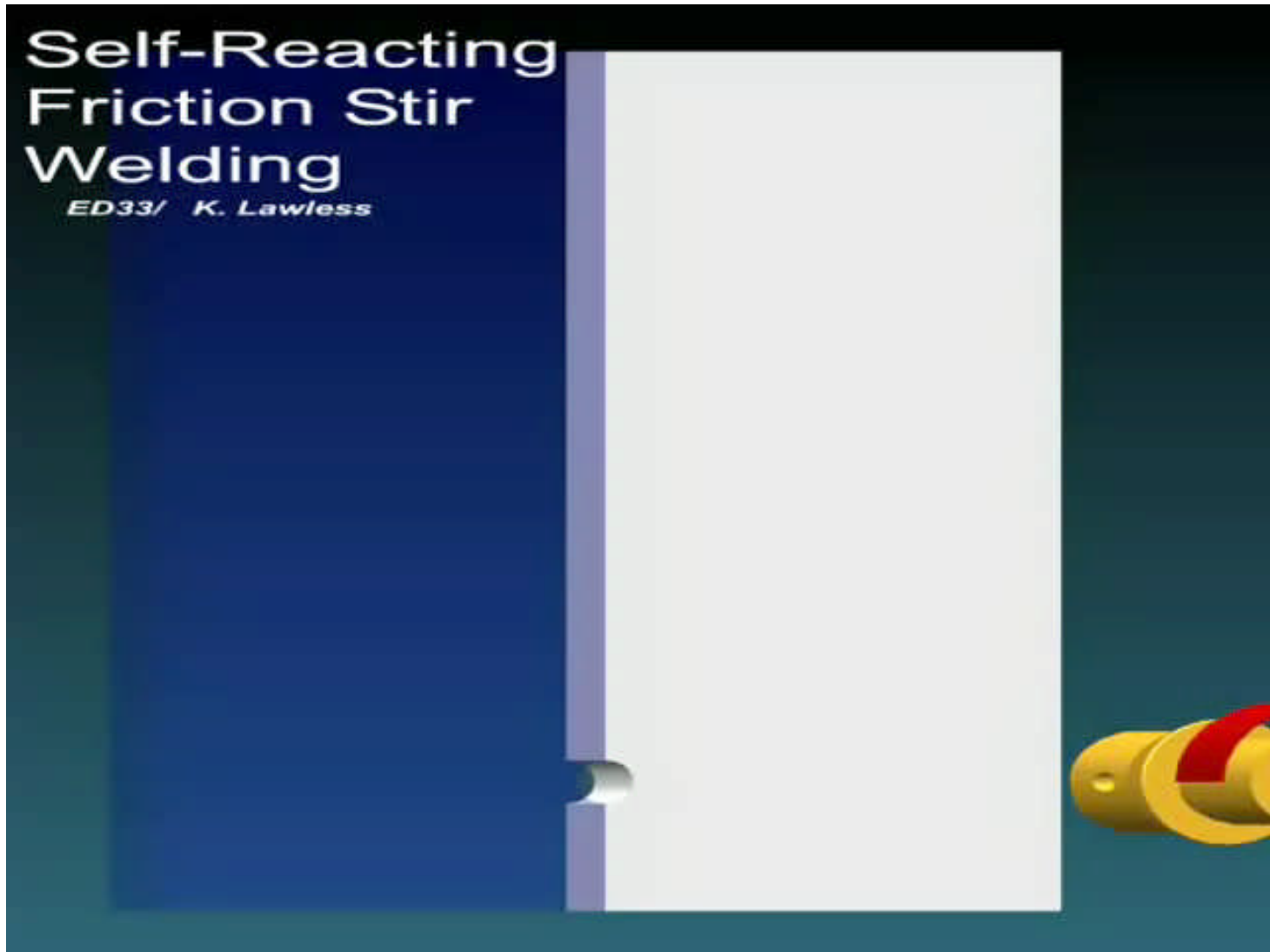
More Serendipity: Vicarious Experience

Tell, Teach, Involve

Most common (and ineffective) mirror alignment

Vastly improved coverage

[Note – Presentation of this slide includes audience participation.]

©http://www.seattleauto.net/driving/a-quick-and-easy-way-to-eliminate-blind-spots

The Take-Home

Tell me, and I forget . . .
Teach me, and I learn . . .
INVOLVE me, and I remember

35% Presentation, 65% Application

Partners!

Formal ISD   Rich Environments
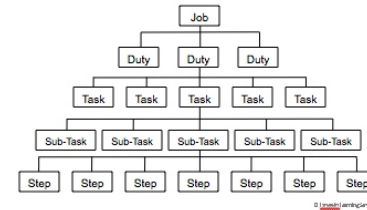
20% of efforts --> 80% of results

With a little help from training professionals, line organizations can "grow their own" training and certification program.

Emphasize Doing

Tailor Training to Task and Learner

Invest in Instructor Skill