U.S. Spacesuit Knowledge Capture Status and Initiatives

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The National Aeronautics and Space Administration (NASA), other organizations and individuals have been performing United States (U.S.) spacesuit knowledge capture since the beginning of space exploration via publication of reports, conference presentations, specialized seminars, and classes instructed by veterans in the field. Recently, the effort has been more concentrated and formalized whereby a new avenue of spacesuit knowledge capture has been added to the archives through which videotaping occurs, engaging both current and retired specialists in the field presenting technical scope specifically for education and preservation of knowledge or being interviewed to archive their significance to NASA's history. Now with video archiving, all these avenues of learning are brought to life with the real experts presenting their wealth of knowledge on screen for future learners to enjoy. U.S. spacesuit knowledge capture topics have included lessons learned in spacesuit technology, experience from the Gemini, Apollo, Skylab and Shuttle programs, hardware certification, design, development and other program components, spacesuit evolution and experience, failure analysis and resolution, aspects of program management, and personal interviews. These archives of actual spacesuit legacy now reflect its rich history and will provide a wealth of knowledge which will greatly enhance the chances for the success of future and more ambitious spacesuit system programs. In this paper, NASA's formal spacesuit knowledge capture efforts will be reviewed and a status will be provided to reveal initiatives and accomplishments since the inception of the more formal U.S. spacesuit knowledge program. A detail itemization of the actual archives will be addressed along with topics that are now available to the general NASA community and the public. Additionally, the latest developments in the archival relationship with the Smithsonian will be discussed.

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Nomenclature

AES	=	Advanced Exploration Systems (Program)
EMU	=	extravehicular mobility unit
ETDD	=	Enabling Technology Development and Demonstration (Program)
ETDP	=	Exploration Technology Development Program
EVA	=	extravehicular activity
Fig	=	figure
FY	=	fiscal year
ISS	=	International Space Station
JOLP	=	JSC Organizational Learning Program
JSC	=	Johnson Space Center
KC	=	knowledge capture
KM	=	knowledge management
MOD	=	Mission Operations Directorate
NASA	=	National Aeronautic and Space Administration
NASM	=	National Air and Space Museum
NEO	=	Near Earth Object
SATERN	=	System for Administration, Training, and Education Resources for NASA
SME	=	subject matter expert
U.S.	=	United States

I. Introduction

THE U.S. spacesuit has become an international icon for NASA and is one of the iconic national treasures of the space industry. Without spacesuits, humans could not have ventured into space, explored the moon, constructed space stations, or maintained and upgraded the Hubble Space Telescope that has provided millions of images that have amazed and educated humankind. These historical accomplishments of U.S. spacesuits are reflected in Fig. 1 as they have been captured realizing those legacy breakthroughs of space exploration.[1]

The U.S spacesuit remains a priority for NASA. Highlighted in NASA's Fiscal Year (FY) 2012 Performance Plan is a goal stating, "Develop advanced spacesuits to improve the ability of astronauts to conduct Extravehicular Activity (EVA) operations in space including assembly and service of in-space systems and exploration of surfaces of the Moon, Mars, near-Earth objects (NEOs), and other small bodies.[2]

Figure 1. Legacy spacesuit montage.

The development of an advance spacesuit to meet this performance goal has resulted in a historic transition from the past. A spacesuit development opportunity has not ensued since the beginning of the Space Shuttle program over 30 years ago with the debut of the Extravehicular Mobility Unit (EMU). In order for a new spacesuit to be technically sound and successful, engineers will need to build future systems based on knowledge gained from the past. The knowledge required will be dependent upon a chronology of lessons learned from developments accumulated through decades of EVA experience in operational programs such as Mercury, Gemini, Apollo, Skylab, Space Shuttle, and International Space Station (ISS). Knowledge from more recent developments will come from progress made in the last 5 years, stimulated by the Constellation Program, Exploration Technology Development Program (ETDP), Enabling Technology Development and Demonstration (ETDD) Program, and the Advanced Exploration Systems (AES) Program.[3]

Capturing knowledge through experience gained over the years becomes even more important now than ever with the development of a new spacesuit. Knowledge from the past has been "captured" through lessons learned and a multitude of venues documented in the publication of reports (failure and scientific), conference presentations, briefings, specialized seminars, photographs, analyses, audio and visual media, logs and memories of veterans in the field. Due to the rich history of NASA's knowledge base on spacesuits, it is imperative that these historical experiences be preserved so a legacy such as the U.S. spacesuits can be passed on for future spaceflight knowledge transfer. Therefore, a new knowledge-capture program was initiated in NASA's Space Suit and Crew Survival Systems Branch in 2007. This paper reviews NASA's U.S Spacesuit Knowledge Capture program providing a status of the efforts over the last five years, reviews collaborative partners, and identifies new initiatives introduced to augment the development of our nations next generation spacesuit, facilitate innovation, reduce future redundant work, potentially reduce "training time," help adapt to a changing environment in space exploration, and provide several options for sharing this knowledge with the public.

II. U.S. Spacesuit Knowledge Capture Program Goals and Objectives

Knowledge management (KM) is getting the right information to the right people at the right time, and helping people create knowledge and share and act upon information in ways that will measurably improve the performance of NASA and its partners. For NASA this means delivering the systems and services that will help our employees and partners get the information they need to make better decisions. There are three priority areas where KM systems and processes can help NASA's ability to deliver its missions: [4]

1. To sustain NASA's knowledge across missions and generations
   KM activities will identify and capture the information that exists across the Agency
2. To help people find, organize, and share the knowledge we already have
   KM processes will help to efficiently manage the Agency's knowledge resources
3. To increase collaboration and to facilitate knowledge creation and sharing
   The Knowledge Management Team will develop techniques and tools to enable teams and communities to collaborate across the barriers of time and space

In May 2008 the Johnson Space Center (JSC) Director released the first JSC Policy Directive related to knowledge management (KM). The JSC Organizations were encouraged to promote knowledge transfer, collaborative sharing, and learning required for the success of the NASA missions. The JSC Chief Knowledge Officer (CKO) (established in 2006) was given the authority to plan and implement KM programs at JSC, including prescription and publication of guidelines. It also established the JSC Organizational Learning Program (JOLP), to implement the policy, standards, and Center-wide enterprise architecture for all KM activities.[5]

In 2007, the U.S. Spacesuit Knowledge Capture program was formed and has increasingly aimed to meet the JSC Policy Directive along with serving the need of educating engineers that will be required to design, develop, and test new spacesuit hardware and systems. The program is managed out of the Space Suit & Crew Survival Systems Branch by a spacesuit project engineer. The focus of the program is to capture knowledge and preserve lessons learned from subject matter experts well known for their expertise in EVA, spacesuits, and portable life support systems.

The main sources of information to be captured include: (1) recollections, conclusions, and recommendations of experts; (2) information in written, video, and audio formats; and (3) hardware items representing not only flight items and flight configuration items, but mock-ups, advanced prototypes, and training hardware.[1] Due to the fact that spacesuit technology involves intimate connection with human beings, the learning from the experiences of the past is not only cost effective; it can be life saving.

III. U.S. Spacesuit Knowledge Capture Collaborators

Many organizations are engaging in knowledge capture at NASA and specifically JSC. A JSC center-wide Knowledge Management assessment was completed in May, 2007. The assessment revealed that many KM activities were ongoing in various organizations at JSC.[5] Several of those entities at JSC that engage in KM or knowledge capture include the JSC Engineering Academy, the Mission Operations Directorate (MOD) Training Academy, and the JSC KM Program.

The U.S. Spacesuit Knowledge Capture (KC) program is a specialized activity ongoing at JSC that specifically focus on capturing the historical knowledge of spacesuits and their associated technologies. In order to make this specialized program a success, several collaborators are involved across JSC and its associated contractor community. These collaborators are itemized below:

1) **U.S. Spacesuit KC Project Lead** – The project lead oversees the entire program, secures the funding to administer the program, executes a KC Plan, approves all of the events, provides technical, cost, and status reviews to the customer, the JSC EVA Projects Office.
2) **Technical and Administrative Support** – These services are provided by the Engineering Services Contract. This team provides the administrative services for managing the logistics associated with obtaining the relative knowledge and archiving the records for historical and learning purposes. They coordinate every aspect of arranging a U.S. Spacesuit KC event from securing a lecturer to documenting the material for processing the events through export control.
3) **Recording Personnel** – This team is committed to providing the best recording capability possible. They provide the recording venue, record the U.S. Spacesuit KC events and submit recorded product to the U.S. Spacesuit KC Lead. The services of this team are provided via a Memorandum of Understanding signed by both the Mission Operations and Engineering Directorates at JSC. The personnel are assigned to the MOD Training Academy and provide services to the U.S. Spacesuit KC program on a non-interference bases with the events lead by the MOD Training Academy.
4) **Subject Matter Experts (SMEs)** – These are the experts that actually conduct the lectures for the U.S. Spacesuit KC program. These are internal NASA and contractor employees and they can be external such as NASA retirees.
5) **JSC History Office** – This office has agreed to provide an interviewer for those events whereby the expert is interviewed. The JSC Oral History Project Coordinator serves as the interviewer. This joint venture by the U.S. Spacesuit KC program and the JSC History Office will also allow for the transcription of all interviews and the audio recording will also be made available on the JSC History Office website, http://www.jsc.nasa.gov/history/oral_histories/oral_histories.htm.
6) **JSC Engineering Academy** – Alls events produced by the U.S. Spacesuit KC program will be archived with the JSC Engineering Academy on their JSC internal website once taken through the export control process, http://ea.jsc.nasa.gov/Ea_web/html/emplsrv/academy/index.asp . Also, the JSC Engineering Academy Council led by the JSC Engineering Academy Dean has the approval authority for all U.S. Spacesuit KC events for outside experts such as NASA retirees. Objectives of the JSC Engineering Academy are to provide a learning environment for professional development and technical training directed at increasing the breadth and depth of engineering discipline knowledge.[6]
7) **JSC Human Resources Representatives** – This team is responsible for processing requests from the U.S. Spacesuit KC program seeking approval from the JSC Engineering Academy to execute an event from an outside entity such as a NASA retiree. They provide consultation on event planning and assist in documenting lectures in the System for Administration, Training, and Educational Resources for NASA (SATERN), whereby attendees can obtain training credit for attending U.S. Spacesuit KC events. SATERN website: https://satern.nasa.gov//customcontent/splash_page/SATERN_Splash.html
8) **Engineering Directorate (EA) Information Technology (IT) Representative** – This representative is responsible for steaming all of the U.S. Spacesuit KC program video and archiving the product with the JSC Engineering Academy. This is a resource provided by the Engineering Directorate since the U.S. Spacesuits KC events benefit the JSC Engineering Academy.
9) **NASA Scientific and Technical Information (STI) center -** The STI Center houses a sizeable collection of JSC, NASA, and other government documents, a small collection of reference books, journals, and a variety of electronic resources that assist JSC employees and contractors in their work. The NASA Center for AeroSpace Information (CASI) is a blend of people and systems that interact to acquire, process, archive, announce, and disseminate STI. NASA CASI is the operational arm of the NASA STI Program Office. STI is input into the NASA Aeronautics and Space Database (NA&SD), which contains over 4 million records. Records are indexed and digitized daily, and then added to the database in near-real time. Publicly available STI is also input into a public interface, the NASA Technical Reports Server (NTRS). Once U.S. Spacesuit KC events are process through the export control, they will be archived with one or more of the following systems and links:
    a. **NTRS - Publicly available**: *http://ntrs.nasa.gov*

b. **NA&SD – Not publicly available**: *https://www2.sti.nasa.gov*
c. **NASA CASI (Center for AeroSpace Information) YouTube** *http://www2.youtube.com/user/nasacasi*

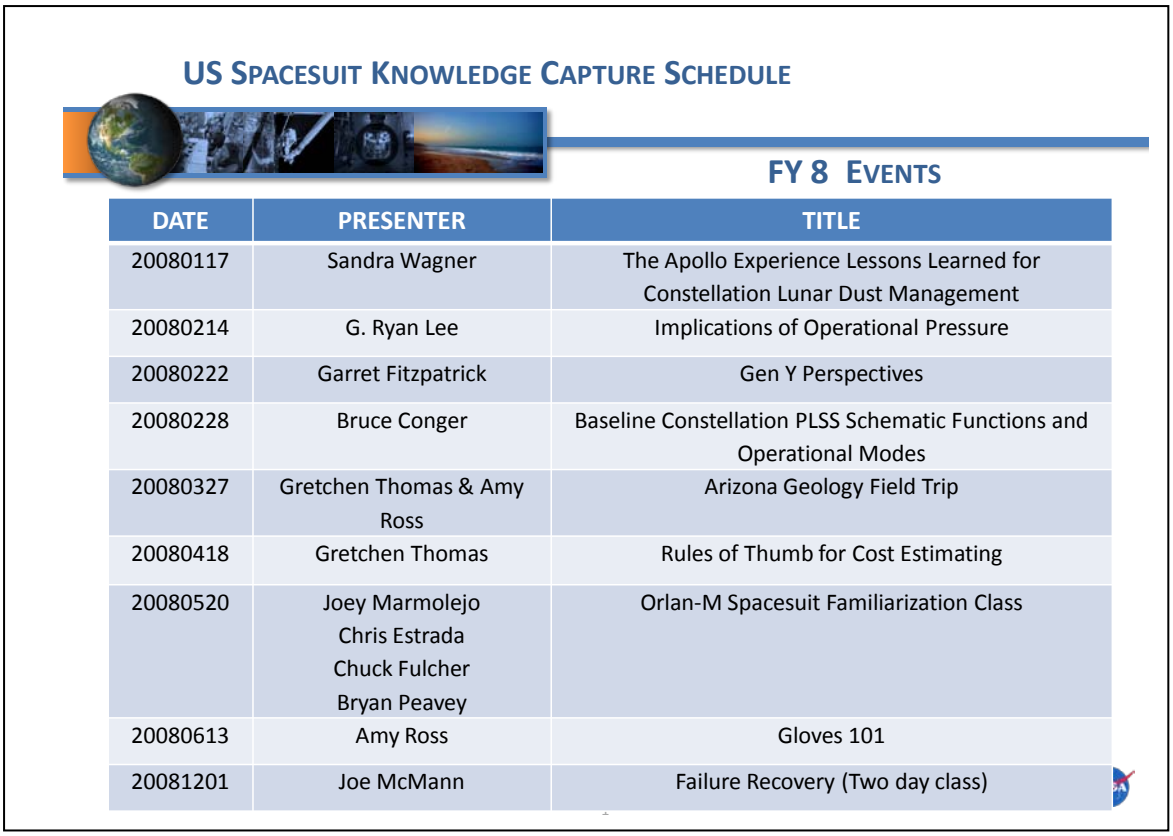
10) **Smithsonian Institution National Aeronautic and Space Museum (NASM)** – The caretaker of more than 1200 spacesuit artifacts of the U.S. space program. Included in that number are more than 270 pressure suits, and their component gloves, helmets, boots, and attachments. NASM obtained the suits, parts, and components in its collection largely through a "NASA-NASM" Agreement between the museum and NASA signed in March 1967. This agreement granted the museum the right of first refusal of artifacts after NASA had finished with them for programmatic purposes. The agreement granted the museum the collection and responsibility for preserving the artifacts of the space age. Today the NASM curatorial department must rely on the suits themselves and the memories of the participants to tell this story.[1]Therefore, the U.S. Spacesuit KC program and the NASM are collaborating once again so that the physical preservation of spacesuit hardware and knowledge base remains with NASM.

IV. Summary of Accomplishments and Events

When the U.S. Spacesuit KC program began in 2007, the first two full years (FY2008 and FY2009) were dedicated to getting the program up and running. The project lead initiated the program with no funding and with limited time to accomplish the tasks. However, interest increased as the new spacesuit was being developed and knowledge management was being encouraged. Initially a goal was set to achieve from one to two KC events per month. Funding was awarded to augment the program and the program has been off and running ever since. A chronological portrayal of the events held since U.S. Spacesuit KC inception is summarized in this section.

A. FY 8 Accomplishments

- U.S. Spacesuit KC program kicked off
- Established recording collaborations
- Initiated extensive discussions with SMEs for planning purposes
- Accomplished 9 KC events as shown in Fig. 2.

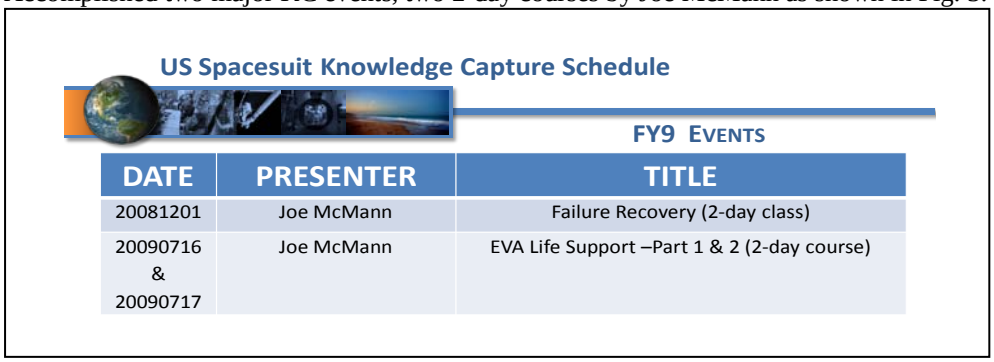


DATE	PRESENTER	TITLE
20080117	Sandra Wagner	The Apollo Experience Lessons Learned for Constellation Lunar Dust Management
20080214	G. Ryan Lee	Implications of Operational Pressure
20080222	Garret Fitzpatrick	Gen Y Perspectives
20080228	Bruce Conger	Baseline Constellation PLSS Schematic Functions and Operational Modes
20080327	Gretchen Thomas & Amy Ross	Arizona Geology Field Trip
20080418	Gretchen Thomas	Rules of Thumb for Cost Estimating
20080520	Joey Marmolejo Chris Estrada Chuck Fulcher Bryan Peavey	Orlan-M Spacesuit Familiarization Class
20080613	Amy Ross	Gloves 101
20081201	Joe McMann	Failure Recovery (Two day class)

Figure 2. FY2008 U.S. Spacesuit Knowledge Capture Events

B. **FY 9 Accomplishments**

- U.S. Spacesuit KC program continued
- Resources to manage program were limited
- Accomplished two major KC events, two 2-day courses by Joe McMann as shown in Fig. 3.



DATE	PRESENTER	TITLE
20081201	Joe McMann	Failure Recovery (2-day class)
20090716 & 20090717	Joe McMann	EVA Life Support –Part 1 & 2 (2-day course)

Figure 3. FY2009 U.S. Spacesuit Knowledge Capture Events

C. **FY 10 Accomplishments**

- U.S Spacesuit KC program gaining interest and thriving
- Additional funding was secured to sustain the program
- Accomplished 9 KC events as shown in Fig. 4.

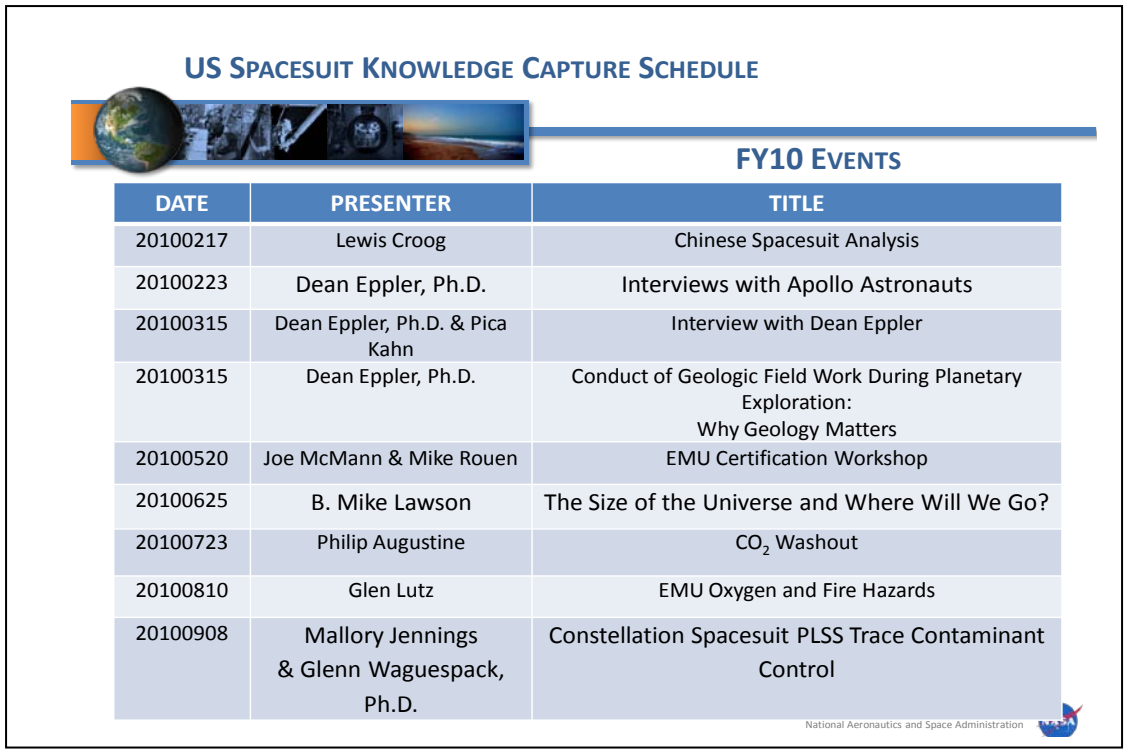


Figure 4. FY2010 U.S. Spacesuit Knowledge Capture Events

D. **FY 11 Accomplishments**

- Published first paper on US Space Suit Knowledge Capture (Historical & Lessons Learned perspective)
- Presented Paper at 2011 ICES Conference in Portland
- Established collaborations with Smithsonian for spacesuit hardware and recordings – Dr. Cathleen Lewis (Submitted a proposal to Smithsonian Network about spacesuits)
- Secured Engineering and Mission Operations Directorates Memorandum of Understanding to use Recording Studio at no cost up to 5 hours/month – Signed by Associate Directors in both Directorates
- Secured Human Resource funding to augment Knowledge Capture events for external SMEs
- Accomplished 11 KC Events with one 2-day extensive course shown in Fig. 5

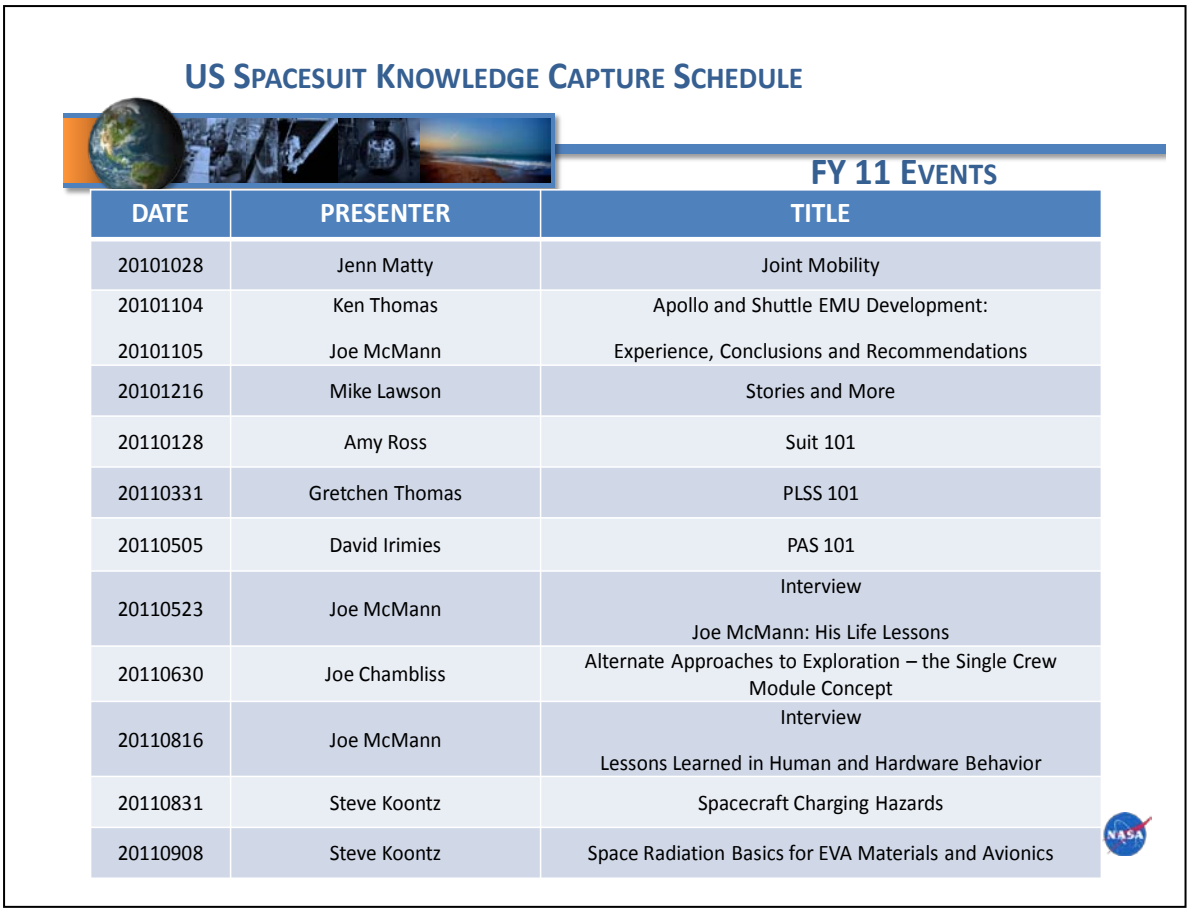
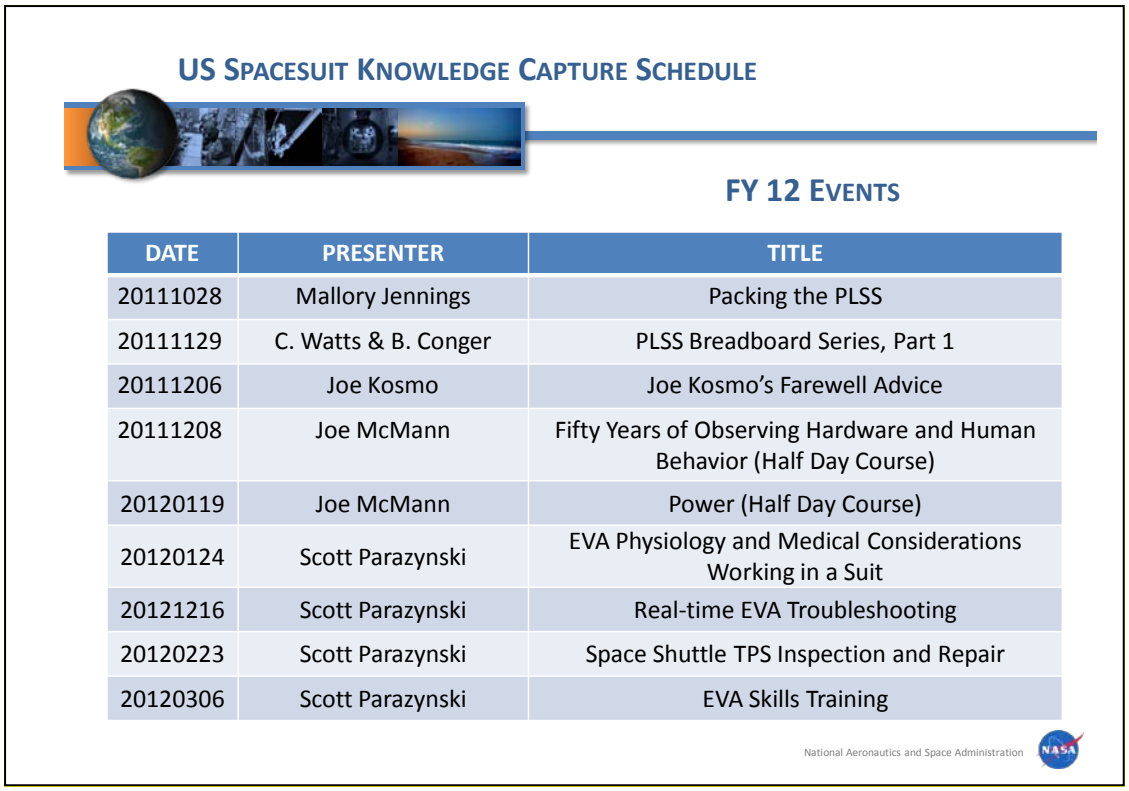


Figure 5. FY2011 U.S. Spacesuit Knowledge Capture Events

- **FY 12 Accomplishments and Initiatives**
  - Initiated Challenge: Increase events from 1 to 2 per month
  - Engage the JSC History Office in Interviews - Rebecca Wright (JSC Oral History Project Coordinator) agreed to conduct interviews for U.S. Spacesuit KC events
  - In addition to archived recordings, the audio will be archived with the JSC Oral History Project and made public (vetted through legal)
  - Written transcription of audio will be accomplished at no cost
  - Secured Human Resource budget to augment KC events for external SMEs
  - Prepared a 2012 ICES Paper entitled "U.S. Spacesuit Knowledge Capture Status and Initiatives" – Focus on accomplishments
  - Designed and released a U.S. Spacesuit KC Catalog
  - Continued to archive recordings with the JSC Engineering Academy
  - Processed KC events through Export Control process (Form 1676)
  - Publicly released viable recordings - NASA Technical Library
  - NASA Technical Library release first U.S. Spacesuit KC event to YouTube
  - By the end of FY12, the U.S. Spacesuit KC program will have held 19 KC events as shown in Figs. 5a and 5b.



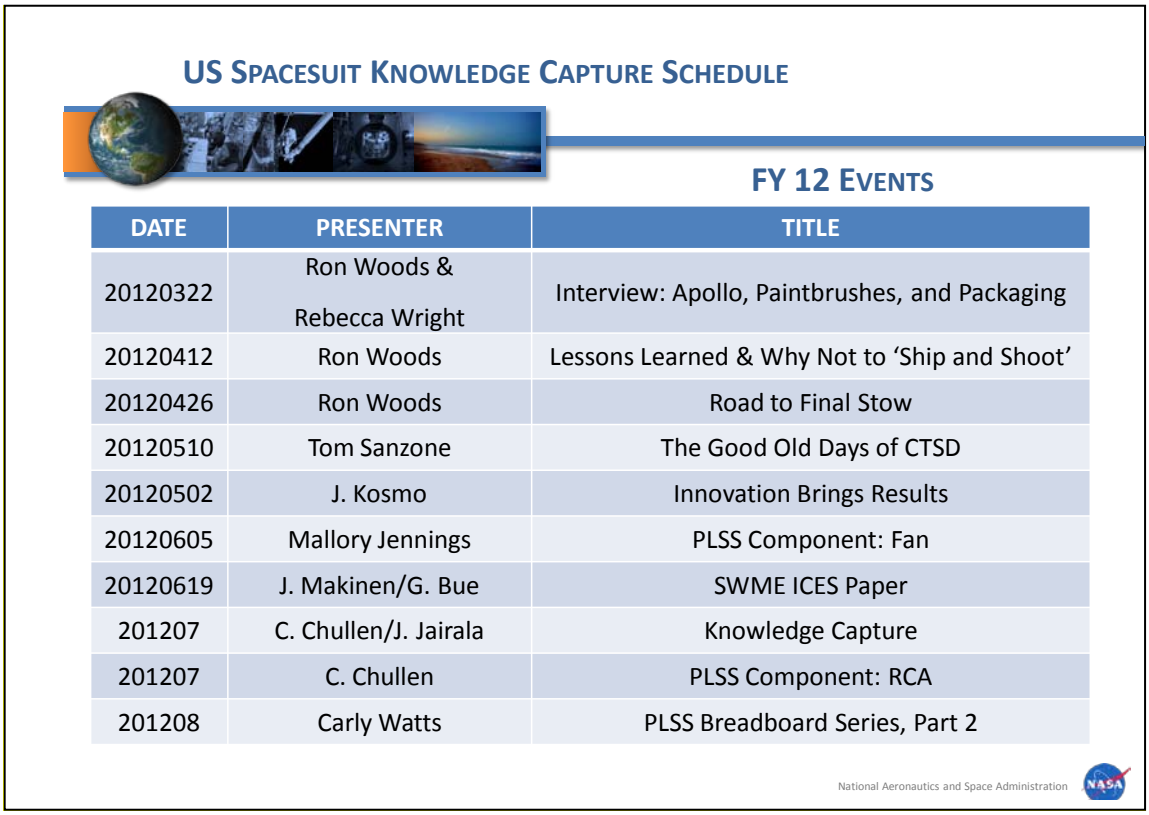
US SPACESUIT KNOWLEDGE CAPTURE SCHEDULE

FY 12 EVENTS

DATE	PRESENTER	TITLE
20111028	Mallory Jennings	Packing the PLSS
20111129	C. Watts & B. Conger	PLSS Breadboard Series, Part 1
20111206	Joe Kosmo	Joe Kosmo's Farewell Advice
20111208	Joe McMann	Fifty Years of Observing Hardware and Human Behavior (Half Day Course)
20120119	Joe McMann	Power (Half Day Course)
20120124	Scott Parazynski	EVA Physiology and Medical Considerations Working in a Suit
20121216	Scott Parazynski	Real-time EVA Troubleshooting
20120223	Scott Parazynski	Space Shuttle TPS Inspection and Repair
20120306	Scott Parazynski	EVA Skills Training

National Aeronautics and Space Administration

Figure 5a. FY2012 U.S. Spacesuit Knowledge Capture Events



US SPACESUIT KNOWLEDGE CAPTURE SCHEDULE

FY 12 EVENTS

DATE	PRESENTER	TITLE
20120322	Ron Woods & Rebecca Wright	Interview: Apollo, Paintbrushes, and Packaging
20120412	Ron Woods	Lessons Learned & Why Not to 'Ship and Shoot'
20120426	Ron Woods	Road to Final Stow
20120510	Tom Sanzone	The Good Old Days of CTSD
20120502	J. Kosmo	Innovation Brings Results
20120605	Mallory Jennings	PLSS Component: Fan
20120619	J. Makinen/G. Bue	SWME ICES Paper
201207	C. Chullen/J. Jairala	Knowledge Capture
201207	C. Chullen	PLSS Component: RCA
201208	Carly Watts	PLSS Breadboard Series, Part 2

National Aeronautics and Space Administration

Figure 5b. FY2012 U.S. Spacesuit Knowledge Capture Events

III. Featured U.S. Spacesuit Knowledge Capture Events

The events held by the U.S. Spacesuit KC program are varied. The tenets of spacesuit knowledge capture include: Lunch-N-Learns; Training Courses; Expert Lectures; and Formal Interviews. For spacesuit knowledge to be useful to others while benefiting the organization as a whole, it must be shared. Valuable technical information is successfully captured for spacesuit knowledge-capture endeavors by providing a venue in which subject matter experts (SMEs) lecture and present their tacit knowledge of spacesuits and topics relating to spacesuits to both a live audience and in formal interviews.

For both formats of knowledge capture to be useful to others, the live audience lectures are taped, as are the interviews are. The benefit of taping all knowledge-capture spacesuit events is that each event will be available for others to view at their leisure for educational purposes for years to come. These taped events add to the legacy of spacesuit education because each event will be cataloged/archived and saved, creating a recorded educational spacesuit collection. It is also important to record the actual questions being asked by the audience. This is valuable because a learner listening to the lecture that is already recorded will be affected in the same way as a listener who actually was there. Two such events (lecture and interview) are highlighted in this section.

A. **Lecture**

Topic: Fifty Years of Observing Hardware and Human Behavior
Presenter: Joe McMann
Synopsis: This half-day workshop consisted of a presentation of the lessons learned by Joe McMann during his 50 years of experience in both industry and government, which included all U.S. manned space programs, from Mercury to the International Space Station. He shared his thoughts about hardware and people and what he has learned from first-hand experience. Included were such topics as design, testing, design changes, development, failures, crew expectations, hardware, requirements, and meetings.
Biography: Joe McMann graduated from the University of Notre Dame in 1959 with a bachelor of science in chemical engineering. He joined NASA in 1961 as a member of the Space Task Group. During his 35-year NASA career, he was a Project Engineer on the Apollo Environmental Control System; a Project Engineer, Technical Manager, and Test Subject on the Gemini and Skylab Extravehicular Activity (EVA) life support systems; and a Subsystem Manager, Test Subject, and Contract Technical Manager for the space shuttle Extravehicular Mobility Unit (EMU) and Manned Maneuvering Unit (MMU). Joe has coauthored "U.S. Spacesuits" with Kenneth S. Thomas of Hamilton Sundstrand (Praxis Press, 2005). He also has conducted training on failure recovery planning and practical project management and has lectured on lessons learned during more than 40 years of experience in the aerospace industry.

B. **Interview**

Topic: Apollo, Paintbrushes, and Packaging – an Interview with 40-year Spacesuit Veteran Ron Woods
Presenter: Ronald Woods (interviewed by Rebecca Wright)
Synopsis: Ron Woods exhibits a wealth of knowledge gathered in more than 40 years of experience with NASA and spacesuits. His biography, progression of work at NASA, impact on the US Spacesuit, and career accomplishments are of interest to many. Rebecca Wright from the JSC History Office will conduct a personal background interview with Ron. This interview will highlight the influences and decision making methods which impacted his technical and management contributions to the Space Program. Attendees will gain insight on the external and internal NASA influences on career progression within the Spacesuit field of work and the type of accomplishments and technical advances that can be made by committed individuals.
Biography: Ron Woods' career at NASA began at the Johnson Space Center, Crew Systems Division, as a survival technician and suit subject for the Apollo suits. Ron then supported the training and pre-flight suiting activities for Apollo, Skylab and Apollo-Soyuz Test Project (ASTP) at the Kennedy Space Center. During this time, he was assigned to the teams that supported the crews of Apollo 8, 11, 15, all three Skylabs and ASTP. Post ASTP, Ron returned to JSC in support of Shuttle Flight Crew equipment. This included The Launch Entry Suit (Ejection Seat Equipment) and Crew Worn Equipment. Ron supported the first two Shuttle missions as a suit technician at KSC and three additional missions at primary and back up landing sites, White Sands and Dryden Flight Research Center. From 1982 to 2011, Ron worked at KSC as the JSC Flight Crew Equipment representative for each Shuttle

Mission and the early ISS missions. Ron's primary career and his already developing artistic skills merged into a portfolio of spacesuit paintings. Today Ron is back at JSC working launch/entry suits and crew protection systems for future human space exploration.

Biography: Rebecca Wright serves as the Coordinator for the NASA Johnson Space Center History Office, responsible for the overall management of the office. Her duties include community outreach, the history websites, publication efforts, oral history, research staff and resources. As an Oral Historian for the space agency, she has interviewed approximately 350 individuals since 1997 for a number of projects. She recently completed work as co-editor on ***NASA at 50***, a book scheduled to be released later this year by the NASA Headquarters History Office. She is currently facilitating a pictorial history publication effort titled, ***Johnson Space Center: The First Fifty Years***.

IV. Conclusion

Knowledge Management is a strategic objective for NASA. The U.S. Spacesuit KC program has proven to be vital in meeting a strategic objective for NASA. This program is important and has provided a mechanism for retaining pertinent knowledge of the spacesuits. This program is at the forefront and timely as a new spacesuit is being designed, assembled, tested, and the architecture is being established. Knowledge is being shared and learning is being encouraged to help improve performance, facilitate innovation, reduce future redundant work, potentially reduce "training time," and help adapt to a changing environment in space exploration. The knowledge being archived comes from the knowledge of those who learned before us so those who come after us can continue to explore, push the envelope, and live in space so that we can go farther, do better, and know more in the process. This paper provided a status and revealed initiatives associated with program so that the information is communicated and preserved. Perhaps the greatest challenges facing our knowledge-capture system consist of first making sure that those who could benefit from it know of its existence, second of knowing how to use it, and third understanding the importance of archiving spacesuit history so as future engineers and managers can benefit from our nation's investment. The value of knowledge capture was best expressed by the parent of an elementary student: "We don't always reach our expectations and we don't always win; it's the lessons from the journey that we carry with us [that] mean the most over time."

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References

[1]Chullen, C., McMann, J., Dolan, K., Bitterly, R., and Lewis, C., "U.S. Spacesuit Knowledge Capture", AIAA-2011-5199-488, *41st International Conference on Environmental Systems,* Portland, Oregon, July 2011.

[2]Fiscal Year 2012 Performance Plan, NASA's Website, URL: http://www.nasa.gov/offices/ocfo/budget/strat_plans.html [cited March, 2012]

[3]Chullen, C. and Westheimer, D., "Extravehicular Activity Technology Development Status and Forecast", AIAA-2011-5179-554, *41st International Conference on Environmental Systems,* Portland, Oregon, July 2011.

[4] NASA's Knowledge Management Website, http://www.km.nasa.gov/whatis/index.html [cited March, 2012].

[5]Johnson Space Center Knowledge Management Website, http://www.km.nasa.gov/home/km_jsc.html [cited March 2012].

[6]Johnson Space Center Engineering Academy Website, http://ea.jsc.nasa.gov/Ea_web/html/emplsrv/academy/index.asp [cited March 2012)].