National Aeronautics and Space Administration

NASA/TM—2016–218221

Marshall Space Flight Center
Research and Technology Report 2015

Report extract, focused on ai-one™ solution project

NASA/TM—2016–218221

Marshall Space Flight Center

Research and Technology Report 2015

A.S. Keys, M.L. Tinker, A.D. Sivak, and H.C. Morris, Compilers
Marshall Space Flight Center, Huntsville, Alabama

Acknowledgments

The points of contact and coordinator at Marshall Space Flight Center (MSFC) for this Technical Memorandum (TM) are Mike Tinker (256–544–4973) and Heather Morris. The MSFC Office of Center Chief Technologist recognizes Troy Farsoun, Vicki Hocutt, and Mary Vaughn of the MSFC Scientific and Technical Information Group for assisting in the development of this report. The Center Chief Technologist, Andrew Keys, Deputy Chief Technologist, Mike Tinker, Technologist, Amy Sivak, and Technologist, Heather Morris, provided the support, knowledge, insight, and decisions needed for compilation of this TM.

TRADEMARKS

For additional copies of this report contact:

NASA STI Information Desk
Mail Stop 148
NASA Langley Research Center
Hampton, VA 23681–2199, USA
757–864–9658

This report is available in electronic form at
<http://www.sti.nasa.gov>

FOREWORD

Marshall Space Flight Center is essential to human space exploration, and exploration propels technological advancements. As we solve the challenges of expanding human presence deeper into the solar system than ever before, we advance technology on Earth, further scientific knowledge and discovery, create new economic opportunities, and continue to lead the world in space exploration.

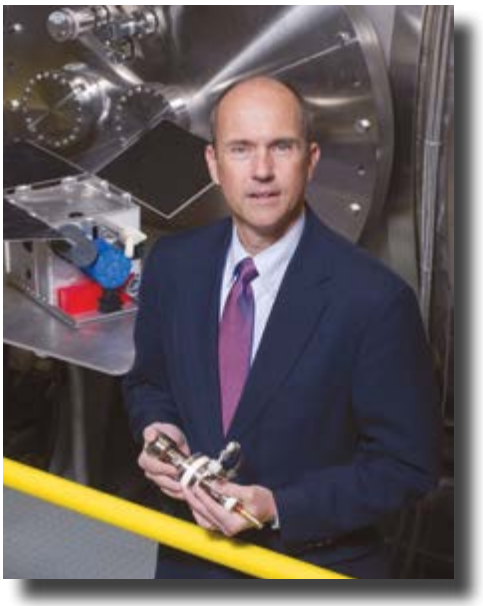
The investments in technology development we made in 2015 not only support the Agency's current missions, but they will also enable new missions. Some of these projects will allow us to develop an in-space architecture for human space exploration; Marshall employees are developing and testing cutting-edge propulsion solutions that will propel humans in-space and land them on Mars. Others are working on technologies that could support a deep space habitat, which will be critical to enable humans to live and work in deep space and on other worlds. Still others are maturing technologies that will help new scientific instruments study the outer edge of the universe–instruments that will provide valuable information as we seek to explore the outer planets and search for life.

While each project in this report seeks to advance technology and challenge our way of thinking, it is important to recognize the immense variety of work being done in support of our mission. This report highlights Marshall's reputation for solving complex problems and shows the progress that has been made this past year. These scientists, researchers, and technologists are enabling technology that will facilitate NASA's ability to fulfill the ambitious goals of innovation, exploration, and discovery for years to come.

I hope you enjoy reviewing this report. It has been an exciting year and has set the stage for even more progress in 2016.

Todd A. May
Center Director
Marshall Space Flight Center

INTRODUCTION



I am honored to present the Marshall Space Flight Center Research and Technology Report for 2015. Our immensely talented workforce is pursuing a wide variety of research and technology efforts, and this document showcases their impressive work. From early stage innovations developed in the Center Innovation Fund program to advanced technologies that were investigated to enable future Space Launch System capabilities, the efforts detailed in this report should advance the current state of technology such that future NASA missions are enabled.

Marshall's technologists achieved significant accomplishments in projects funded by Human Exploration and Operations Mission Directorate (HEOMD), including the Advanced Exploration Systems Program and Space Launch System Advanced Development. The HEOMD work was managed by the Space Launch Systems Office and the Flight Programs and Partnerships Office.

Outstanding progress was also achieved in technology projects funded by Space Technology Mission Directorate (STMD), including efforts in the Technology Demonstration Missions Program, Centennial Challenges Program, Game Changing Development, Center Innovation Fund, Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR), and Small Spacecraft Technology Program. These efforts were managed by the Science and Technology Office and the Flight Programs and Partnerships Office.

Technology efforts at MSFC funded by the Science Mission Directorate (SMD) included work in the Astrophysics Division and the Planetary Science Division's Mars Exploration Program. This work was managed by the Science and Technology Office.

Finally, MSFC Center Management and Operations funded efforts such as the Technology Investment Program, Center discretionary investments, and Dual-Use Technology Cooperative Agreement Notice. This work was managed by the Office of Strategic Analysis and Communications and the Center Strategic Development Steering Group.

The innovations described within this report may serve to not only enhance and enable NASA's near-term programs and projects, but could also provide the solutions required for future Mars missions, human and robotic exploration of other solar system bodies, and destinations beyond. I trust that you will enjoy reviewing the Marshall research and technology accomplishments of 2015.

Andrew Keys
Center Chief Technologist
Marshall Space Flight Center

TABLE OF CONTENTS

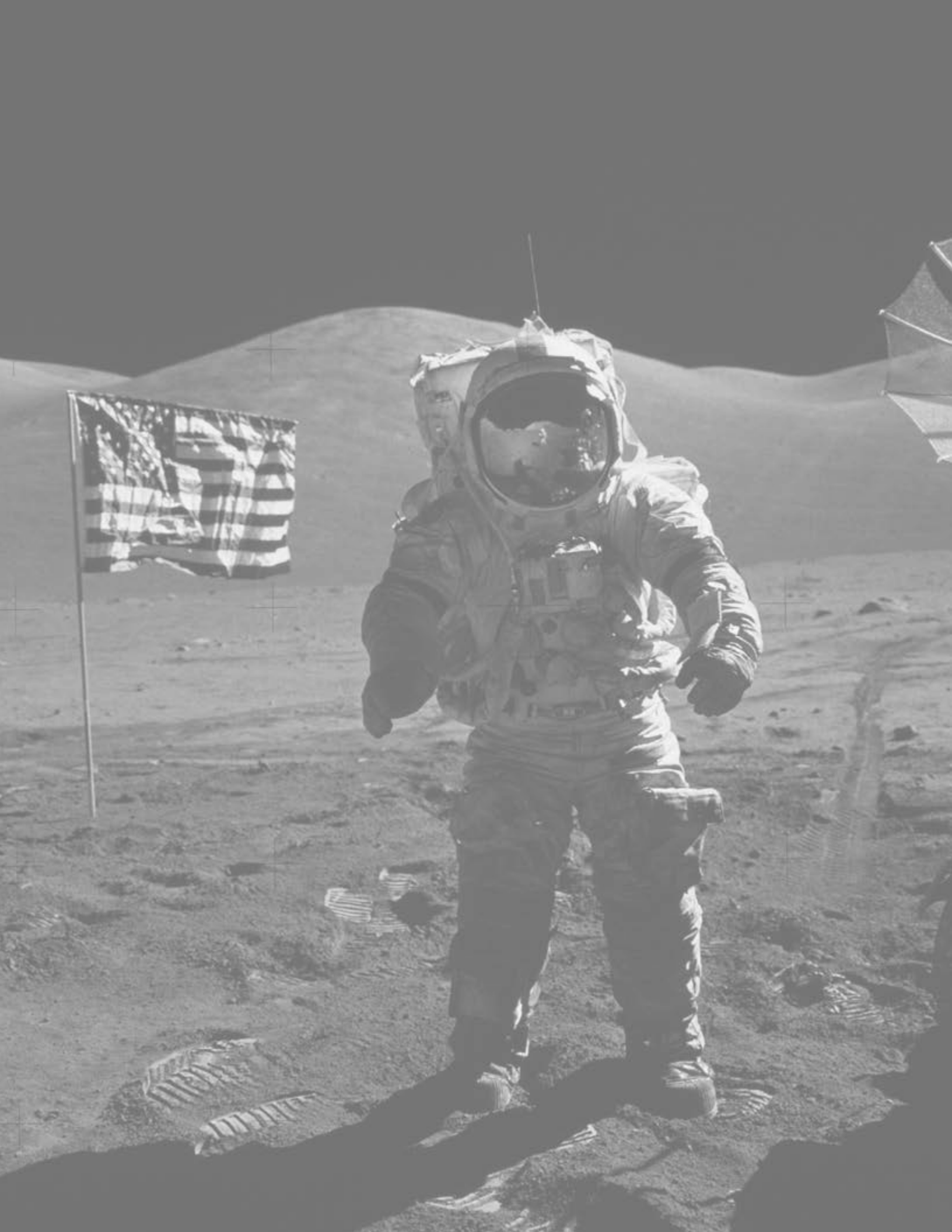
Report extract, focused on ai-one™ solution project on page 198

TABLE OF CONTENTS (Continued)

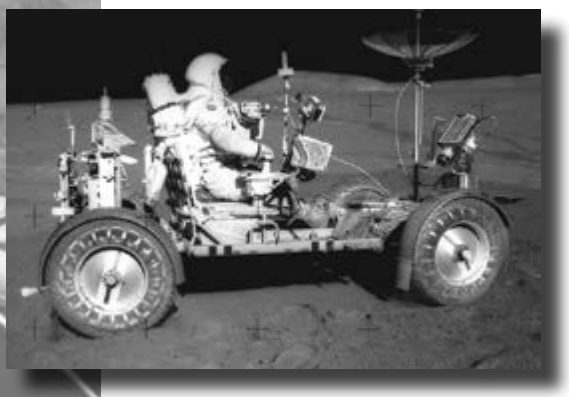
Report extract, focused on ai-one™ solution project on page 198

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)



Human Exploration and Operations Mission Directorate



Human Exploration and Operations Mission Directorate

Advanced Exploration Systems

Topic Mapping

Project Manager(s)

Mark Rogers/ED04
(256) 544–6969

Pat Hunt/ED04
(256) 544–2297

Gregory Funaro/ED04
(256) 544–3747

Thomas Marsh/ai-one, inc.
(858) 531–0674

Jeremy Toor/ISC Consulting Group
(520) 508–8501

Sponsoring Program(s)

Marshall Space Flight Center/Center Management and Operations
Dual-Use Technology Cooperative Agreement Notice

Project Description

The Advanced Concepts Office (ACO) performs conceptual design and analysis on many far-reaching missions, which requires significant technology development. The intent is to help guide NASA's technology development programs and to quantify through analysis the benefits of those technologies. The Agency's programs and projects, by their very nature, frequently require the development and infusion of new technological advances to meet mission goals, objectives, and resulting requirements. Figure 1 depicts the relationship between architectural studies and technology assessments.

Key to the technology assessment process is an understanding of program and Agency goals, technology capabilities, the collection of the technology data, and the actual technology assessments. The process requires significant input in the form of interviews with technologists throughout the industry/government/academia. Technology assessments also require the input from multiple discipline analysts.

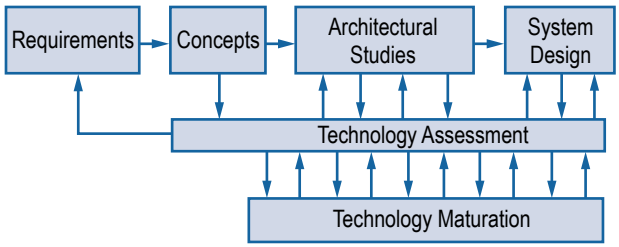


Figure 1: Relationship between concepts, architectural studies, and technology assessments.

The technology assessment process is laborious and time intensive due to the nature of assembling and obtaining input from multiple discipline experts. ACO is attempting to improve the process by using state-of-the-art technology in computer text and content analytics. ACO is collaborating with two leading experts in this field: ai-one™ and ISC Consulting Group.

ai-one is a recognized Who's Who in text analytics technology, which will enable ACO to obtain information from almost any digital source, in any language, regardless of its structure (or lack of structure). ISC Consulting Group has experience working with the ai-one technology to obtain and classify information for the United States Army Intelligence Center.

ACO is testing the ai-one technology by performing a technology assessment of wireless sensors. ACO collected data on wireless sensors from the NASA Technical Reports Service repository, which returned 230 documents, which amounts to approximately 10,000 paragraphs, or 3,000 pages, of technical information from all NASA Centers from the years 2000–2015.

With the help of the ai-one technology and support from ISC Consulting Group, ACO created 45 agents to represent various avionics system designs. This was done not through programming, but by providing each agent a few paragraphs describing each avionic system. The 10,000 paragraphs were then evaluated by each agent and scored on how well the wireless sensor paragraphs matched the capabilities described by the avionics system. That amounts to 450,000 assessments.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
01–04–2016	Technical Memorandum	October 2014–September 2015

4. TITLE AND SUBTITLE

Marshall Space Flight Center Research and Technology Report 2015

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

A.S. Keys, M.L. Tinker, A.D. Sivak, and H.C. Morris, Compilers

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

George C. Marshall Space Flight Center
Huntsville, AL 35812

8. PERFORMING ORGANIZATION REPORT NUMBER

M–1411

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

National Aeronautics and Space Administration
Washington, DC 20546–0001

10. SPONSORING/MONITOR'S ACRONYM(S)

NASA

11. SPONSORING/MONITORING REPORT NUMBER

NASA/TM—2016–218221

12. DISTRIBUTION/AVAILABILITY STATEMENT

Unclassified-Unlimited
Subject Category 12
Availability: NASA STI Information Desk (757–864–9658)

13. SUPPLEMENTARY NOTES

Prepared by the Office of the Director, Center Chief Technologist

14. ABSTRACT

Many of NASA's missions would not be possible if it were not for the investments made in research advancements and technology development efforts. The technologies developed at Marshall Space Flight Center contribute to NASA's strategic array of missions through technology development and accomplishments. The scientists, researchers, and technologists of Marshall Space Flight Center who are working these enabling technology efforts are facilitating NASA's ability to fulfill the ambitious goals of innovation, exploration, and discovery.

15. SUBJECT TERMS

MSFC Research and Technology Report 2015, engineering, science, technology

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			STI Help Desk at email: help@sti.nasa.gov
U	U	U	UU	222	19b. TELEPHONE NUMBER *(Include area code)* STI Help Desk at: 757–864–9658

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, AL 35812
www.nasa.gov/marshall

www.nasa.gov