National Aeronautics and
Space Administration

Office of Inspector General
Washington, DC 20546-0001

February 19, 2008

TO: Director, Marshall Space Flight Center
NASA Chief Engineer

FROM: Assistant Inspector General for Auditing

SUBJECT: Addendum to Final Memorandum on Marshall Space Flight Center's Approach to Establishing Product Data Management and Mechanical Computer-Aided Design Software Tools as Standard Center-Wide (Report No. IG-07-013, July 24, 2007)

We requested additional management comments on the above-referenced final memorandum because we did not consider comments on Recommendations 1 and 2 to be responsive. Management's additional comments, dated August 31, 2007 (see Enclosure 1), and proposed actions were based on consultation with NASA Headquarters Office of the Chief Engineer (OCE) representatives. In view of the guidance provided to Marshall Space Flight Center by the OCE, we consider management's additional comments to be responsive. This addendum provides a summary of management's additional comments, and our evaluation of those comments, as well as discussion of a recommendation to the Chief Engineer that we added in a draft of this addendum (Recommendation 3). We have closed Recommendations 1 and 2 and consider Recommendation 3 to be resolved.

Recommendation 1

In our draft memorandum, issued March 7, 2007, we recommended that the Director, Marshall Space Flight Center, direct the Marshall Director of Engineering to suspend all activities associated with the archiving and migration of data from Teamcenter to Windchill and allow design engineers to continue to use UniGraphics Solutions, Inc. (UGS) product data management (PDM) and mechanical computer-aided design (MCAD) software at then-current version levels for new projects.

In Marshall's April 10, 2007, response to the draft memorandum, management nonconcurred, stating that suspending all activities associated with the archiving and migration of data from Teamcenter to Windchill and allowing design engineers to continue to use UGS PDM and MCAD software at then-current version levels for new projects would significantly impact schedule and risk. The Marshall Associate Director stated that remaining data would be moved after establishment of an acceptable approach for transitioning the data and that any newly defined UGS initiative can use the Design and Data Management System (DDMS) to manage its data. We did not consider

management's planned action to be responsive to the recommendation and requested additional comments in response to the final memorandum.

In Marshall's August 31, 2007, response to the final memorandum, management stated that it would reevaluate the recommendation pending the results of actions agreed upon with regard to Recommendation 2. Marshall stated that it intended to procure additional MCAD licenses as necessary to ensure no disruption to design activities while it conducts the assessments suggested in Recommendation 2. Management comments also stated that "the Integrated Engineering Capability project intends to support" existing UGS and Parametric Technology Corporation's Pro/Engineer (ProE) MCAD applications based on current and projected requirements. We consider management's planned actions, which we have since verified, to be responsive; the recommendation is closed.

Recommendation 2

In our draft memorandum, we recommended that the Director, Marshall Space Flight Center, direct the Marshall Director of Engineering to conduct the required assessment and risk analysis of the Windchill and ProE implementation, in accordance with NASA Procedural Requirements (NPR) 7150.2, "NASA Software Engineering Requirements," September 27, 2004, and NPR 8000.4, "Risk Management Procedural Requirements," revalidated February 1, 2007, and incorporate guidance from the OCE for the selection of MCAD tools for major space systems.

In Marshall's April 10, 2007, response to the draft memorandum, the Marshall Associate Director nonconcurred with the recommendation, stating that Windchill risks had been assessed prior to our recommendations and that additional assessments were not warranted. The Associate Director added that the requirements in NPR 7150.2 and NPR 8000.4 were not applicable and, therefore, further risk analysis of the Windchill and ProE implementation was not required. However, the Associate Director offered to send a reminder to the appropriate official at Marshall to use NPR 7150.2, NPR 8000.4, and guidance from OCE in the selection of MCAD tools for major space systems. Although we agreed that Windchill's risk was assessed, the ProE selection was made approximately 3 years later and without the required risk assessment. We also challenged management's contention that NPR 7150.2 and NPR 8000.4 did not apply. Therefore, we requested additional comments in response to the final memorandum.

In response to the final memorandum, Marshall consulted with the OCE and partially concurred with the recommendation, stating that OCE designated MCAD software as a Development Support Software (Class E), under NPR 7150.2. Management therefore agreed to conduct all Class E analysis, but specifically declined to conduct a continuous risk management program in accordance with NPR 8000.4 because that NPR "is not applicable to the Class E designation." Management further stated that the Marshall Engineering Directorate, in conjunction with the Office of the Chief Information Officer, would perform an alternative analysis based on the current environment to address the intent of the January 26, 2007, OCE guidance, "Information for the Selection of Mechanical Computer-Aided Design (MCAD) Tools," and would forward results to our office.

We confirmed with OCE representatives the Class E designation for MCAD software, despite Class E analysis parameters not including NPR 8000.4 risk analysis requirements. In view of the OCE guidance to Marshall, we consider management's additional comments to be responsive, and the recommendation is closed.

Additional Discussion and Recommendation

Although we resolved the recommendations contained in our final memorandum, NPR 7150.2 requires clarification in order to forestall similar PDM and MCAD classification and analysis issues at other NASA Centers. Specifically, the ambiguities in the current definitions and software classification guidance invite interpretations that could lead to errors in classification of MCAD products and inadequate assessment of risk. Therefore, we provided the following analysis and recommendation in a December 19, 2007, draft of this addendum.

NPR 7150.2 Software Classifications. NPR 7150.2 definitions related to software class assignment could inadvertently lead to errors in the assignment and assessment of risk. NPR 7150.2 identifies eight classes of software (A through H). Appendix B, "Definitions," provides basic definitions for each class. Appendix D, "Requirements Mapping Matrix," identifies management, testing, and other requirements applicable to each class of software. Our review of the software classification definitions in NPR 7150.2 led us to conclude that two classification definitions could logically be applied to MCAD products: Class A, "Human Rated Software Systems," and Class E, "Development Support Software."

The NPR 7150.2 definition of Class A software is as follows:

> Applies to all space flight software subsystems (ground and flight) developed and/or operated by or for NASA to support human activity in space and that interact with NASA human space flight systems. Space flight system design and associated risks to humans are evaluated over the program's life cycle, including design, development, fabrication, processing, maintenance, launch, recovery, and final disposal. Examples of Class A software for human rated space flight include but are not limited to: guidance; navigation and control; life support systems; crew escape; automated rendezvous and docking; failure detection, isolation and recovery; and mission operations.

NPR 7150.2 defines Class E software as

> [n]on-space flight software. Software developed to explore a design concept; or support software or hardware development functions such as requirements management, design, test and integration, configuration management, documentation, or perform science analysis. A defect in Class E software may cause rework but has no direct impact on mission objectives or system safety. Examples of Class E software include, but are not limited to, earth science modeling, information only websites (non-business/information technology); science data analysis; and low technical readiness level research software.

Both Class A and Class E definitions refer to design functions of software, which creates an ambiguity in determining the classification of software used for design (drafting)

purposes. While we agree that MCAD is not space flight software, MCAD is used by NASA in support of human space flight through design, development, and fabrication. As such, MCAD software is used by many NASA programs that support human activity in space (a key element of the Class A software definition). An example of an application in which MCAD will support human activity in space is MCAD software used in the design and construction of the Upper Stage of the Ares I rocket. MCAD will be used to create the digital data that verifies the acceptability of dimensions and tolerances for parts used to build the rocket.

The significant difference between Class A and Class E software management requirements within NPR 7150.2 is the application of NPR 8000.4. Class A software includes the requirement for continuous risk management; Class E software has no requirement for risk management. Therefore, assignment of MCAD to Class E results in no risk management assessment. Given MCAD's use in the design of human rated space flight components and systems, it would be prudent to ensure that such MCAD software requires risk management.

> **Recommendation 3.** The NASA Chief Engineer should review and clarify the software classification definitions in NPR 7150.2 to minimize potential misclassification of software products and should ensure that software products used in the design or support of human space flight components or systems include risk management as a software management requirement.

We requested that the NASA Chief Engineer provide comments on Recommendation 3. We received additional management comments on January 24, 2008 (see Enclosure 2), that we considered responsive, but required additional collaboration between the OCE and OIG to clarify the intent of the recommendation and OCE's intended actions.

Management's Comments. The Chief Engineer concurred with the first part of our recommendation related to a review and update of NPR 7150.2, stating that the OCE would include that consideration during the regular NPR 7150.2 update cycle, prior to September 24, 2009. However, management did not concur with the second part of our recommendation due to a perceived implication that our recommendation invokes a full NPR 7150.2 Class A risk analysis requirement. The Chief Engineer stated that he was open to considering increased rigor in risk mitigation for commercial off-the-shelf (COTS) MCAD products, as warranted, for inclusion in Section 2.3 (COTS Guidance) of NPR 7150.2.

Evaluation of Management's Comments. We met with representatives from the OCE on February 6, 2008, to clarify the intent of Recommendation 3 and resolve any misunderstandings. As a result, we agreed to revise Recommendation 3, as follows, to better define our intent:

> **Recommendation 3 (Revised).** The NASA Chief Engineer should review and clarify the software classification definitions in NPR 7150.2 to minimize potential misclassification of software products and should ensure that COTS MCAD software products used in the design or support of human space flight components or systems

include an increased level of rigor in risk mitigation as a software management requirement, regardless of software classification within the NPR 7150.2 classification matrix.

We reached an agreement with OCE in the February 6 meeting that OCE would review the definition in the NPR's software classification matrix as part of its planned NPR 7150.2 review. OCE further agreed to include in the revision of NPR 7150.2 specific notation to ensure that COTS MCAD software products receive an increased level of rigor in risk mitigation as a software management requirement, regardless of software classification within the classification matrix.

Comments on Recommendation 3 (Revised). In a February 8, 2008, e-mail (see Enclosure 3), the Chief Engineer concurred with the revised recommendation, stating that OCE will review NPR 7150.2 and make the clarification in the next update of the NPR.

We consider the comments responsive. Recommendation 3 is resolved, but will remain open pending completion of OCE's intended actions.

We appreciate the courtesies extended during the review. If you have any questions, or need additional information, please contact Mr. Vincent Scott, Procurement Director, Office of Audits, at 202-358-0546.

(signed) A. Dahnelle Payson for

Evelyn R. Klemstine

3 Enclosures

cc:
Director, Goddard Space Flight Center
Procurement Officer, Goddard Space Flight Center

Management's Additional Comments on the Final Memorandum

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

August 31, 2007

Reply to Attn of:
DE01

TO: NASA Office of Inspector General
ATTN: Ms. Evelyn Klemstine,
Assistant Inspector General for Auditing

FROM: Associate Director

SUBJECT: Comments on the Final Memorandum on Marshall Space Flight Center's Approach to Establishing Product Data Management (PDM) and Mechanical Computer-Aided Design (MCAD) Software Tools as Standard Center-Wide (Report No. IG-07-013; Assignment No. S-07-001-00)

As requested in the subject final memorandum dated July 24, 2007, we submit our responses to the recommendations below. While we do not agree with many of the assertions in the final memorandum, in an effort to move forward we have chosen to focus on the specific recommendations.

***Recommendation 1*. "The Marshall Center Director should direct the Marshall Director of Engineering to suspend all activities associated with the archiving and migration of data from Teamcenter to Windchill and to allow design engineers to continue to use UGS PDM and MCAD software (at current version levels) for new projects."**

Management Response to the Final Memorandum. We will reevaluate the recommendation pending the results of actions agreed to in Recommendation 2. Marshall will continue to procure additional MCAD licenses from appropriate vendor sources as necessary to ensure no disruption to design activities for ongoing projects while the assessments referenced in Recommendation 2 are conducted.

While the balance of computer-aided design (CAD) software usage has changed, the Integration Engineering Capability project intends to support UniGraphics and ProE based on current and projected requirements.

1

Recommendation 2. **"The Marshall Center Director should direct the Marshall Director of Engineering to conduct the required assessment and risk analysis of the Windchill and ProE implementation, in accordance with NPR 7150.2 and NPR 8000.4, and incorporate OCE guidance for the selection of MCAD tools for major space systems."**

Management Response to the Final Memorandum. Concur as follows: In consultation with the Office of the Chief Engineer (OCE), who is responsible for NPR 7150.2, it was determined that acquisition of new CAD applications, like ProE and UG NX, would be categorized as Class E, Development Support Software. Under the Class E designation, a continuous risk management program and NPR 8000.4 are not applicable. We agree to address the applicable NPR 7150.2 requirements; however, we will not conduct a risk analysis in accordance with NPR 8000.4 since it is not applicable to the Class E designation.

Additionally, the Marshall Engineering Directorate, in conjunction with the Office of the Chief Information Officer, will perform an alternative analysis based on our current environment to address the intent of the January 26, 2007 OCE guidance, "Information for the Selection of Mechanical Computer-Aided Design (MCAD) Tools." We will also properly document the results and provide the information to your office by the projected closure date of the recommendation.

Corrective Action Official:	Marshall Director of Engineering
Corrective Action Closure Official:	Marshall Associate Director
Projected Closure Date:	January 14, 2008

If you have any questions or need additional information regarding our comments, please contact Ms. Keri Roberts at (256) 544-2953 or keri.h.roberts@nasa.gov.

Robin N. Henderson

Robin N. Henderson

Management's Comments on the Draft Addendum

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

January 24, 2008

Reply to Attn of: Office of the Chief Engineer

TO: Assistant Inspector General for Auditing

FROM: Chief Engineer

SUBJECT: Draft Addendum to Final Memorandum on Marshall Space Flight Center's Approach to Establishing Product Data Management and Mechanical Computer-Aided Design Software Tools as Standard Center-Wide (Report No. IG-07-013, July 24, 2007)

The following is in response to Recommendation 3 of the subject report: *The NASA Chief Engineer should review and clarify the software classification definitions in NPR 7150.2 to minimize potential misclassification of software products and should ensure that software products used in the design or support of human space flight components or systems include risk management as a software management requirement.*

In response to the Draft Addendum of Report No. IG-07-013, issued December 19, 2007, the NASA Chief Engineer fully concurs with the *first half* of Recommendation 3 to review and clarify the software classification definitions in NPR 7150.2 as a part of the next NPR update cycle. We will assess how existing programs are using the classification definitions, review suggested improvements, and consider the impacts to existing NASA programs that would result from changes. Since the NPR is up for renewal before September 24, 2009, the Office of the Chief Engineer (OCE) will act upon this recommendation during the planned update in FY09.

However, we do not concur with the second part of Recommendation 3 as written (i.e., "... and should ensure that software products used in the design and support of human space flight components or systems include risk management as a software management requirement"). This text along with informative material in the Draft Addendum of Report No. IG-07-013 appear to imply that software products used in the design or support of the development of human space flight components should also fulfill NPR 7150.2's Class A requirements in the area of risk management. It should be noted that OCE has been responsive to various request for clarifications to NPR 7150.2 via OCE's NASA Software web site (at software.nasa.gov see "Frequently Asked Questions), a number of telecon exchanges, and emails. While we are open to considering increasing the rigor of risk mitigation when it comes to Commercial Off the Shelf Software (COTS) supplied Mechanical Computer-Aided Design (MCAD) software which is currently classified as "E" software, we do not consider it a candidate for the highest classifications. We anticipate

that increases in the rigor of applicable requirements related to risk mitigation would be addressed in Section 2.3 of NPR 7150.2, if warranted. In discussions with the IG representatives we noted that Section 2.3 already has a fairly comprehensive and proven requirement for COTS software in addition to the recently developed OCE guidelines for the selection of MCAD. As the wording in Recommendation 3 is a "Draft Addendum" from the IG, OCE would be willing to participate in updating this portion of the recommendation to more agreeable final wording.

Michael G. Ryschkewitsch

cc:
Office of Internal Controls and Management Systems/Mr. Roberts
Director, Marshall Space Flight Center

Management's Comments
on Recommendation 3 (Revised)

Scott, Vincent M. (HQ-WAH10)

From: Ryschkewitsch, Mike (HQ-KA000)
Sent: Friday, February 08, 2008 3:06 PM
To: Scott, Vincent M. (HQ-WAH10)
Cc: Bell, Harold M. (HQ-KE000); Kelly, John C. (HQ-KE000); Crumbley, Robert T. (MSFC-ES01)
Subject: Re: IG-070-013 Draft Addendum Memorandum on MSFC APPROACH to ESTABLISHING PDM and MCAD...

Hello Vince -

I concur with the revised Recommendation 3. OCE will conduct the review and make the clarification with the intention of incorporating it into the next update of the subject NPR in CY 2009 unless new information comes to light indicating a need to accelerate that schedule.

Mike Ryschkewitsch

From: "Scott, Vincent M. (HQ-WAH10)" <Vincent.M.Scott@nasa.gov>
Date: Fri, 8 Feb 2008 11:41:12 -0600
To: "Ryschkewitsch, Mike (HQ-KA000)" <mike.ryschkewitsch@nasa.gov>
Cc: "Bell, Harold M. (HQ-KE000)" <harold.m.bell@nasa.gov>, "Kelly, John C. (HQ-KE000)" <john.c.kelly@nasa.gov>, "Crumbley, Robert T. (MSFC-ES01)" <tim.crumbley@nasa.gov>
Conversation: IG-070-013 Draft Addendum Memorandum on MSFC APPROACH to ESTABLISHING PDM and MCAD...
Subject: IG-070-013 Draft Addendum Memorandum on MSFC APPROACH to ESTABLISHING PDM and MCAD...

Mr. Ryschkewitsch (NASA Chief Engineer):

In the NASA Office of Chief Engineer (OCE) January 24, 2008 response to the subject Draft Addendum Memorandum, OCE concurred with the first part of our Recommendation 3 related to the review and clarification of software classification definitions within NPR 7150.2. OCE did not concur with the second part of our recommendation (related to risk management) due to a perceived implication that our recommendation invoked a full NPR 7150.2 Class A Risk Analysis requirement. Response comments further stated that OCE was open to considering an increase in the rigor of risk mitigation when it comes to Commercial Off the Shelf (COTS) Mechanical Computer Aided Design (MCAD) software and indicated that OCE was open to further discussion.

On February 6, 2008 I met with your designated OCE representatives. During that meeting, we discussed OCE concerns and OIG perspective with regard to the initial wording of Recommendation 3. We agreed on the spirit and intent of the initial recommendation and that clarification of the Recommendation could resolve OCE reservations, while adequately addressing OIG concerns. To that end, we further agreed on the revised wording of the Recommendation. The proposed revised wording is as follows:

Recommendation 3. The NASA Chief Engineer should review and clarify the software classification definitions in NPR 7150.2 to minimize potential misclassification of software products and should ensure that Commercial Off the Shelf (COTS) Mechanical Computer Aided Design (MCAD) software products used in the design or support of human space flight components or systems include an increased level of rigor in risk mitigation as a software management requirement, regardless of software classification within the NPR 7150.2 classification matrix.

If OCE concurs with the entirety of the revised Recommendation 3, please indicate your concurrence in reply Email to this correspondence. Upon receipt of OCE concurrence the revised language and reference to concurrence will be included in the Final Addendum Memorandum.

R/

Vincent M. Scott
Director of Procurement Audits
Office of Audits
NASA Office of Inspector General
(202) 358-0546

2/8/2008