



Office of Inspector General
Washington, DC 20546-0001

July 24, 2007

TO: Director, Marshall Space Flight Center

FROM: Assistant Inspector General for Auditing

SUBJECT: 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; Assignment No. S-07-001-00)

Product Data Management (PDM) and Mechanical Computer-Aided Design (MCAD) software tools play a critical role in NASA's implementation of the President's Vision for Space Exploration. A PDM is an information system used to manage data (e.g., plans, geometric models, MCAD drawings, images, as well as all related project data, notes and documents) for a product as it passes from engineering to manufacturing. MCAD is a computer-based toolset that assists engineers, architects and other design professionals in their mechanical design activities.

PDM and MCAD tools are in use at all NASA Centers. The annual investment in PDM and MCAD support approaches \$2 million a year for Marshall Space Flight Center alone. Moreover, these software tools are critical to the integrity of data underpinning NASA programs and projects. PDM and MCAD products are available from several vendors. Although many aspects of PDM and MCAD applications are similar, regardless of vendor, each vendor product has inherent differences in applications, user interface, and interoperability with other vendor products. The scope of PDM and MCAD requirements across the Agency and the requirement for Centers to collaborate and share engineering data increases the importance of employing an objective selection process for PDM and MCAD products to ensure the most effective and efficient collaborative exchange with minimal risk of data loss or misinterpretation.

On August 23, 2006, we reported on "NASA's Acquisition Approach Regarding Requirements for Certain Engineering Software Tools to Support NASA Programs" (Assignment No. S-06-012-00), an Office of Inspector General (OIG) review conducted in response to complaints regarding NASA's standardization of software tools. We found that the allegation was credible and determined that the Agency was taking action to establish PDM and MCAD software tools of one vendor (Parametric Technology Corporation [PTC]) as the de facto NASA standard without an Agency-wide technical assessment and analysis to justify and support this standardization as required by NASA. As a result, we recommended that the Office of the Chief Engineer (OCE) expand a NASA Engineering and Safety Center (NESC) study to encompass an Agency-wide assessment of PDM and MCAD requirements and determine whether any PDM and

MCAD products should be established as standard. In response to our recommendation, the OCE issued guidelines for the selection of MCAD tools used in the design and development of space systems in the OCE's "Information for the Selection of Mechanical Computer-Aided Design (MCAD) Tools" report, dated January 26, 2007.

After our August report, we received additional complaints that the Marshall Space Flight Center (Marshall) was trying to establish PDM and MCAD software tools from one vendor, again PTC, as the standard for Space Exploration Vehicle design at the Center. The complaints alleged that the Center did not conduct a risk analysis for the PDM or an assessment or risk analysis for the MCAD, as required by NASA's Procedural Requirements (NPR) for software used in human space flight systems. Establishment of an MCAD tool as a standard without an assessment or risk analysis might cause data translation and integration errors with NASA projects, Centers, and contractors using other MCAD tools and, consequently, cause substantial unanticipated expense associated with correction of unforeseen issues. In response to those complaints, we conducted this review of PDM and MCAD software at Marshall. See Enclosure 1 for details on the review's scope and methodology.

Executive Summary

We found that Marshall had assessed three PDM products in April 2002. The assessment included an analysis of the technical, integration, and licensing factors for each product and resulted in recommending and selecting PTC's Windchill as the primary PDM for Marshall engineering. However, we also found that the July 2005 selection of PTC's Pro/Engineer (ProE) as the standard MCAD for new flight system designs was made without an assessment or risk analysis. In addition, the selection process did not, in accordance with NASA requirements, take into account customer and other stakeholder requirements and operational requirements (or, of course, the NASA OCE's 2007 Agency-wide assessment of PDM and MCAD requirements). We found this to be in conflict with established Agency policy requiring a robust assessment and risk analysis of alternatives. Therefore, we recommended that Marshall suspend efforts to establish PTC products as standard and allow design engineers to continue to use UniGraphics Solutions, Inc. (UGS), PDM and MCAD software pending an assessment and risk analysis of the Windchill PDM and ProE MCAD software implementation, in accordance with the OCE guidance and in compliance with applicable NPRs.

Specifically, our March 7, 2007, draft of this memorandum recommended that the Marshall Center Director direct the Marshall Director of Engineering to (1) suspend all activities associated with the archiving and migration of data from UGS's Teamcenter to PTC's Windchill and allow design engineers to continue to use UGS PDM and MCAD software (at current version levels) for new projects and (2) conduct the required assessment and risk analysis of the Windchill and ProE implementation, in accordance with NPR 7150.2, "NASA Software Engineering Requirements," September 27, 2004, and NPR 8000.4, "Risk Management Procedural Requirements," April 25, 2002, and incorporate OCE guidance for the selection of MCAD tools for major space systems.

In response to our draft memorandum, management provided comments on our findings and conclusions and nonconcurred with our recommendations, stating that the suspension of archiving and migration activities and the continued use of UGS software tools impact schedule and risk. Management also stated that further risk analysis of the Windchill and ProE implementation is not required because requirements in NPR 7150.2 and NPR 8000.4 were not applicable.

We recognize that a completed technical assessment and risk analysis may result in showing that the selection of PTC software as the standard MCAD for Marshall is appropriate. However, management's comments are not responsive because Marshall engineering officials were unable to provide us risk management (RM) data that supported their assertion that continued use of UGS PDM and MCAD software or suspending archiving and migration would increase risk. We also disagree with management's statement that requirements in NPR 7150.2 and NPR 8000.4 are not applicable. Documentation provided by Marshall engineering officials showed that ProE was selected in July 2005; the effective date of NPR 7150.2 was September 27, 2004. The July 2005 ProE MCAD selection was the beginning of the MCAD standardization process at Marshall, which involves software acquisition, maintenance, and operations. Paragraph 2.3 of NPR 7150.2 states that it is applicable to software development, maintenance, operations, management, acquisition, and assurance activities started after its effective date of issuance. Also, paragraph 2.1 of NPR 7150.2 covers software created or acquired by or for NASA, including commercial off-the-shelf (COTS), Government off-the-shelf (GOTS), modified off-the-shelf (MOTS), open source, reuse, legacy, and heritage software. NPR 7150.2, paragraph 4.2.1, states that projects should identify, analyze, plan, track, control, communicate, and document software risks in accordance with NPR 8000.4, "Risk Management Procedural Requirements." Therefore, both NPR 7150.2 and 8000.4 are applicable to the ProE standardization.

Additionally, we identified specific translation issues when converting UGS MCAD models into ProE MCAD and vice versa that further support the need to manage MCAD risks in accordance with NPR 8000.4. Specifically, translation of UGS NX and other MCAD models into ProE and vice versa resulted in unreported import errors and added complexity. Our review of documents showed that ProE MCAD software, for instance, has "Single Solid" modeling limitations that could increase model complexity with additional individually tracked components (parts) and assembly layers required to model the same item, as depicted in the figure on page 11.

In addition, based on the documents that we reviewed, we determined that the cost of just the translation (ignoring other costs, such as training, analysis, integration, and verification) of UGS MCAD model files of the Ares booster first stage (from one vendor) would cost more than \$9 million. In the interest of good stewardship, an expenditure of this magnitude should be premised on a robust analysis of MCAD product variants and capabilities prior to investment.

Although we appreciate the time Marshall management has taken to comprehensively address the issues and concerns raised by our review, we do not consider management's

comments to be responsive. We request that management reconsider its position and provide additional comments in response to this final memorandum.

Background

The Marshall Director of Engineering is responsible for all engineering activities at Marshall, including the activities of the Engineering Programs and Systems Office. The Marshall Engineering Directorate established the Integrated Engineering Capabilities (IEC) Project, part of the Engineering Programs and Systems Office, to improve the management of data and to streamline and integrate engineering software systems at Marshall. The IEC Project team is responsible for the development and implementation of PDM and MCAD tools used in support of flight system designs at Marshall.

PDM software is used to improve management of the engineering process through better control of engineering data, activities, changes, and product configurations. Information stored and managed in PDMs includes MCAD models and drawings as well as associated documents such as requirements, specifications, manufacturing plans, assembly plans, test plans, and test procedures.

MCAD software is used for detailed engineering of 3-dimensional models and or 2-dimensional drawings of physical components. MCAD tools are used throughout the engineering process from conceptual design through development and manufacturing.

Marshall's Selection of MCAD Software Was Not in Compliance with NASA Procedural Requirements

NASA's policy on software engineering and risk management for project activities associated with human space flight systems are included in two NPRs: NPR 7150.2, "NASA Software Engineering Requirements," and NPR 8000.4, "Risk Management Procedural Requirements." NASA programs and projects, at all levels, are expected to comply with applicable NASA NPRs.

Software Selection Criteria. NPR 7150.2, "NASA Software Engineering Requirements," September 27, 2004, provides the minimal set of requirements established by the Agency for software acquisition, development, maintenance, operations, and management. NPR 8000.4, "Risk Management Procedural Requirements," April 25, 2002, provides the requirements and information for applying risk management to programs and projects, as required by NPR 7120.5C, "NASA Program and Project Management Processes and Requirements," March 22, 2005.

Software Requirements. NPR 7150.2, paragraph 3.1, states: "Requirements are based on customer, user, and other stakeholder needs and design and development constraints. The development of requirements includes elicitation, analysis, documentation, verification, and validation. It is important that there is ongoing customer validation of the requirements to ensure the products meet the customer needs."

Paragraph 3.1.1.2 requires that each project “identify, develop, document, approve, and maintain software requirements based on analysis of customer and other stakeholder requirements and the operational concepts.”

Risk Management. NPR 8000.4, paragraph 2.2, outlines the process for identifying the risks (technical and programmatic) specific to a project. Project managers should identify individual risks and clearly describe those risks in terms of both the undesirable event the risk presents as well as the consequences of that event to the project. Project managers should develop a statement of risk for each identified risk. Risks should be summarized, and the actions taken to mitigate or accept the risks should be documented.

On January 26, 2007, the OCE issued “Information for the Selection of Mechanical Computer-Aided Design (MCAD) Tools” as guidelines to assist Centers in their selection of MCAD tools for the design and development of major space systems. Those guidelines state that several factors should be evaluated when selecting an MCAD tool, including the complexity, interoperability, security, training, and the intended use of the tool.

Assessments and Risk Analyses. In April 2002, the IEC Project assessed three PDM products: Teamcenter, developed by UGS; Product Data Exchange, developed by Oracle; and Windchill, developed by PTC. The assessment included an analysis of technical, integration, and licensing factors of each PDM. The IEC Project assessment resulted in the recommendation and selection of Windchill as the primary PDM for Marshall engineering. However, this assessment did not include a risk analysis or recommendation for a primary MCAD tool.

Subsequent to the selection of Windchill, engineering officials at Marshall began to eliminate the option of using Teamcenter. Design engineers were requested to archive and migrate all data resident on Teamcenter to Windchill. To facilitate the elimination process, Marshall engineering officials restricted the use of UGS MCAD software on new design projects and limited UGS MCAD users to technically obsolete version levels.

During March 2005, the Marshall Deputy Center Director asked Marshall engineering officials to determine if there were a common set of MCAD tools that could be used at the Center. The IEC recommended and selected ProE as the standard MCAD for Marshall in July 2005, without an assessment or risk analysis as required by NPRs 7150.2 and 8000.4. At the time IEC selected ProE, Marshall engineers were using a number of different MCAD tools to support flight system designs. In November 2005, after accepting the position, the Marshall Director of Engineering stated that he concurred with the recommendation to establish ProE as the standard MCAD tool at Marshall, even though the required assessment and risk analysis had not been performed.

Our review of user logs showed that the Marshall Vehicle Engineering (EV) Branch is the largest MCAD user group at Marshall, and EV Branch officials stated that any standardization of MCAD tools without an adequate assessment or risk analysis could

lead to unexpected data translation and integration errors when interfacing with NASA projects, Centers, and contractors using “non-ProE” MCAD tools. For example, documents we reviewed show that the design and manufacture of the human-rated solid rocket motors used for Shuttle launches and for the Ares crew launch vehicles are modeled using UGS MCAD tools and will require translation, integration, and other forms of analyses after the data is input into Windchill. However, establishing PTC’s MCAD as standard without an assessment or risk analysis means users may not be aware of the translation and integration problems that might be introduced, thus increasing the level of risk. A robust analysis of translation impacts would likely identify translation deficiencies among MCAD vendors and allow development of compensation protocol in advance of transition. If translation deficiencies are not fully known and acknowledged, data elements may be lost and become unrecoverable subsequent to full transition between products.

In addition, officials in the EV Branch said they were not given an opportunity to provide substantial input during the ProE selection process, noting that their input was limited to five PowerPoint slides at the November 2005 Engineering Management Council meeting, which occurred approximately 4 months after the ProE selection. In the five PowerPoint slides presented, the EV Branch manager showed that EV had begun installing the PTC MCAD and training people in its use. He also presented concerns that switching to the ProE software would immediately deprive EV engineers of their top-down design capabilities, which in turn would delay designs and variations, hamper design/model reusability, and preclude adjusting numerous parts with a single edit, thus leading to at least a doubling of the overall design time. The presentation also showed the schedule for restoring these capabilities to the engineers was about 1 year, noting that the schedule was “success oriented” and that “technical issues with ProE may draw out this process development.” NPR 7150.2, paragraph 3.1.1.2, states that a project shall “identify, develop, document, approve, and maintain software requirements based on analysis of customer and other stakeholder requirements and the operational concepts.” Paragraph 3.1 states that it is “important that there is ongoing customer validation of the requirements to ensure the end products meet the customer needs.” The five-slide presentation at the Engineering Management Council meeting does not meet the intent of NPR 7150.2.

NPR 7150.2 provides specific requirements for the acquisition and integration of software used in support of human space flight systems and notes that requirements should be based on user and other stakeholder needs. The risk management process, as provided in NPR 8000.4, is an organized, systematic decision-making process that efficiently identifies, analyzes, tracks, controls, communicates, and documents risk to increase the likelihood of achieving program and project goals. Compliance with both of these NASA requirements is essential to sound program and project management and vital to safety and mission success.

Management's Comments on the Finding and Evaluation of Management's Comments

The Associate Director, Marshall Space Flight Center, provided comments on our findings and conclusions in addition to our recommendations. Following is a summary of management's "Specific Comments" (see Enclosure 2 for the full text of management's comments).

Management's Comments. Management stated that decisions to use PTC's PDM tools at Marshall were made in 2002 and were based on trade studies of products from three different vendors, including PTC and UGS. The PDM and MCAD selections in question were made 3 years apart in completely separate decision processes with unique business drivers.

Management pointed out that when Marshall decided to use ProE for the majority of its in-house design efforts in 2005, the Center already had experienced years of using many different MCAD tools, including ProE and UGS software. Management stated that the Marshall IEC team went to great lengths to establish and maintain customer and stakeholder requirements, to include weekly IEC stakeholder meetings. The meetings were open to all interested parties to address concerns, establish requirements for new areas of development, and validate implementation approaches. In 2004, the affected design groups were provided an opportunity to vet and validate their requirements.

Marshall cites the current NPR 7120.5D, dated March 6, 2007, as being clear that the requirements are applicable to "current and future NASA space flight programs and projects," noting that this excludes the IEC PDM and MCAD initiatives because they are not space flight initiatives. Marshall quoted NASA Policy Guidance (NPG) 7120.5A, NPG 8000.4, and NPR 7150.2 to further support its position that the requirements are not applicable (see Enclosure 2, pages 3 and 4). The citations included the following:

- "This document . . . shall be used specifically for programs/projects that provide aerospace products or capabilities, i.e., provide space and aeronautics, flight and ground systems, technologies, and operations. It is not required but may be used for other projects, such as nonflight infrastructure . . . or Research & Analysis projects." (NPG 7120.5A, paragraph 2.2)
- "This document provides the basic processes and requirements for the planning and implementation of the RM process . . . It shall be used specifically for programs/projects that provide aerospace products or capabilities. . . . It is not required for other projects (such as research conducted under the Generate Knowledge Crosscutting Process or training and education conducted under the Manage Strategically Crosscutting Process); however, the RM concepts and practices described within this document may be beneficial to other projects, so their application should be considered." (NPG 8000.4, paragraph 2.2)

- “This NPR shall be applied to software development, maintenance, operations, management, acquisition, and assurance activities started after its effective date of issuance [September 27, 2004].” (NPR 7150.2, paragraph 2.3)

Marshall noted that, in regard to NPR 7150.2, the PTC PDM development activity had begun in 2002 and that ProE tools were in use prior to the PTC PDM selection.

Management took exception to our statement suggesting that Marshall engineering officials “limited UGS MCAD users to technically obsolete version levels,” noting the IEC requested that neither UGS nor PTC MCAD software be upgraded until the newer versions could be supported by the data management system because upgrades that are not compatible with information technology architecture will add risk and reduce functionality and efficiency. Management also stated that the IEC did not make any recommendations or decisions to move toward ProE as the in-house MCAD tool. The rebalancing of UGS and ProE MCAD was presented to the Engineering Management Council (EMC), where managers from every department and lab heard all sides of the issue and evaluated the impacts, including risk. Management stated that the EMC decided to proceed with the transition. The decision of the EMC was not well received by all and an appeal was made to the OCE. The NASA Chief Engineer enlisted the help of the NASA Engineering Safety Center (NESC). The NESC made several recommendations, and Marshall engineering took steps to address those recommendations.

Management stated that concerns about data translation and integration of disparate MCAD tools was one of the significant drivers behind the decision to move toward ProE for future in-house design work. Management’s comments also stated that ProE was selected because most other NASA Centers that Marshall interacts with were using ProE, as were contractors for current Orion and Ares design efforts. Marshall gave an illustration of the risk added by the use of UGS MCAD, stating that the current vehicle integration being performed at Marshall, which was initiated in UGS MCAD, requires integrating MCAD data for the Marshall Upper Stage (ProE), Johnson Space Center Crew Exploration Vehicle (ProE), J2-X engine (ProE), and First Stage (I-DEAS)—more conversions of ProE into UGS MCAD than other potential conversion scenarios and, hence, introducing more risk. Management added that this conversion scenario has also rendered integrated models that are unusable for Kennedy Space Center design groups using ProE.

Management’s comments noted that Marshall had been using ProE, UGS, and many other MCAD tools for years prior to the decision in 2005 to use ProE as the primary MCAD tool. Management stated that the decision was not an attempt to eliminate UGS but rather to rebalance use to current needs, adding that Marshall continues to use UGS and ProE MCAD tools as necessary to satisfy design needs. Management reiterated that the IEC team continues to work with all affected design groups, including those in the Spacecraft and Vehicle Systems Department, to address stakeholder requirements, processes, format, and terminology concerns.

Evaluation of Management's Comments. We agree that the Marshall IEC's decision to use PTC's PDM tools was based on trade studies of three different vendors' products and that the PDM and MCAD selections in question were made 3 years apart in completely separate decision processes with unique business drivers. However, the point of our report is that the selection of PTC's ProE as the standard MCAD for new flight system designs was made without an assessment or risk analysis. It has been 5 years since PTC's Windchill was selected as the standard PDM at Marshall and 18 months since ProE was selected. PDM and MCAD capabilities have changed significantly since these selections were made. We believe it would be prudent for management to identify and document risks associated with the selection of ProE MCAD as the standard in accordance with NPR 7150.2 and NPR 8000.4 requirements.

We also agree that Marshall mandated the use of ProE for the majority of its in-house design efforts for new projects in July 2005. However, we disagree that the IEC went to great lengths to establish and maintain customer and stakeholder requirements. Documents prepared by the IEC show that the IEC Project did not begin to identify stakeholder requirements until September 2005, approximately 2 months after ProE was selected as the standard MCAD software for new flight design projects. Further, EV officials stated that they were not included in the decision to establish ProE as the standard MCAD software for Marshall. Based on our review of 2005 Monthly Usage Reports, we determined that the EV Branch was the largest MCAD user group at Marshall. Management contends that NPR 7150.2 does not apply because "the PTC PDM development activity began in 2002 and ProE MCAD tools were in use prior to the PTC PDM selection." But management also states that Marshall "decided to use ProE for the majority of its in-house design efforts" in 2005, which confirms that the standardization of ProE began in 2005—after the September 2004 effective date of NPR 7150.2. In addition, engineering officials reaffirmed the MCAD transition decision in November 2005 during an EMC meeting. Paragraph 2.3 states that NPR 7150.2 shall be applicable to software development, maintenance, operations, management, acquisition, and assurance activities started after its effective date.

We disagree with management's assertion that IEC PDM and MCAD initiatives are excluded from NASA program requirements because they are merely an "infrastructure enhancement." MCAD models are used in support of human space flight systems; they are used for detailed engineering models and drawings of physical components for project activities that support human space flight systems. For example, flight safety decisions, including Flight Readiness of the Space Shuttle, depend on these MCAD tools for evaluating safety critical in flight contingencies. All NASA programs and projects are expected to comply with any applicable NPR. The requirements applicable in each NPR should flow down to lower level project activities managed by designated responsible organizations. The IEC Project was responsible for acquiring and implementing the Windchill PDM and the ProE standardization in direct support of the President's Exploration Vision at Marshall. Therefore, NPR 7150.2 applies directly, since paragraph 2.1 covers software created or acquired by or for NASA, including commercial off-the-shelf (COTS), Government off-the-shelf (GOTS), modified off-the-shelf (MOTS), open source, reuse, legacy, and heritage software. Also, NPR 7150.2

requires compliance with NPR 7120.5C and NPR 8000.4 as they apply to the acquisition and use of software, particularly software used in support of human space flight.

In addition, NPRs 7120.5C and 7120.5D show four major factors to be considered in project development—schedule, cost, technical performance, and risk. Applicable guidance for risk management is contained in NPR 8000.4; paragraph 2.2 outlines the process for identifying the risks (technical and programmatic) specific to a project, to include summarizing identified risks and documenting the actions taken to mitigate or accept the risks. Compliance with this NASA requirement is essential to sound program and project management and vital to safety and mission success.

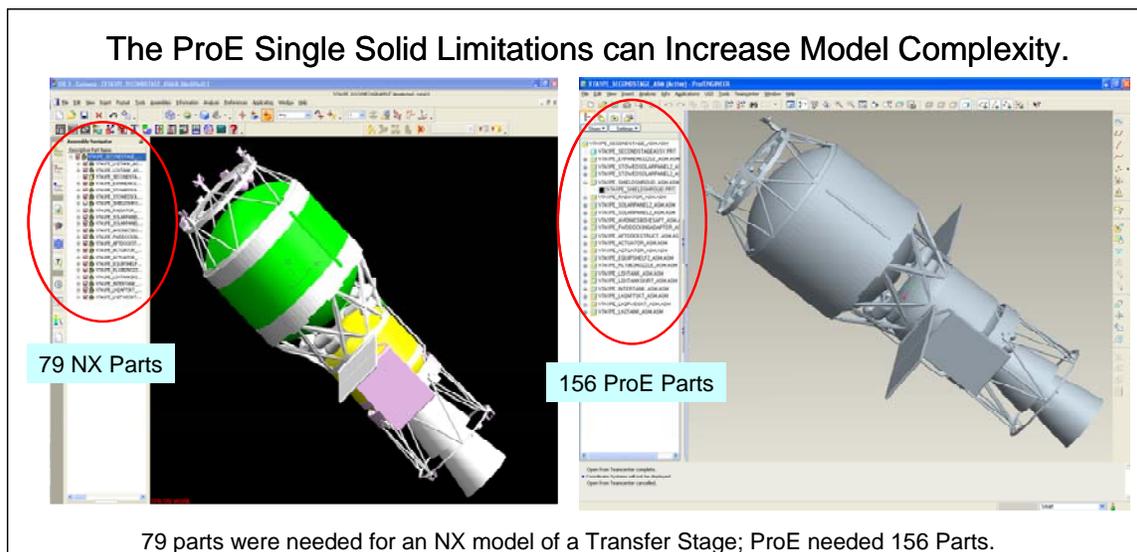
Management stated that the IEC recommended limiting upgrades of all MCAD packages until it could be validated that newer applications or upgrades to existing applications were compatible with the data management system. However, OCE's guidance, "Information for the Selection of Mechanical Computer-Aided Design (MCAD) Tools" states that an evaluation of defined Agency and Center information technology architectures should be made that focuses on compatibility with and duplication of existing tools when making any new tool decisions. If a new PDM tool is chosen that duplicates pre-existing PDM functionality but is incompatible with existing MCAD tools, the new PDM could limit upgrades to existing MCAD tools, forcing the pre-existing MCAD tools to obsolete levels. This is why we recommended performing a risk analysis in accordance with NASA requirements. A risk analysis would help Marshall identify risks and other issues that may be associated with Windchill/ProE standardization. Also, OCE guidance states that factors to be evaluated when selecting an MCAD tool include complexity, interoperability, security, training, and intended use. Priorities have to be weighed to decide the most important factors upon which to base a tool selection decision. Ultimately, an assessment of all appropriate factors will lead to cost and risk determinations that can help establish an overall value of the product under consideration.

Management stated that the Marshall EMC made the decision to transition to ProE. However, we disagree, since the Marshall EMC did not receive its charter until November 2005, approximately 4 months after ProE was selected. The Marshall Deputy Center Director and the Director of Engineering, who serves as the EMC Chair, confirmed that the IEC had the responsibility for identifying and selecting a standard MCAD tool for flight design and stated they did not know how the decision to transition to ProE was made. Management also stated that the ProE decision, which was not well received, resulted in an appeal to the OCE, which solicited help from the NESC. However, the OCE request was not vetted through the NESC Review Board and a full independent technical assessment was not conducted by the NESC. In addition, the engineering officials at Marshall were unable to provide us with any documentation that they had implemented the resulting NESC recommendations.

Management also stated that data translation and integration of disparate MCAD tools was a significant factor considered in selecting ProE. However, management was unable to provide any documentation identifying the factors considered in the ProE selection. Management also stated that most of the other NASA Centers and contractors for the

Orion and Ares design efforts were using ProE. However, we noted that Johnson was the only NASA Center standardized on ProE when the selection was made and that NASA contractors were using a combination of UGS and PTC products. In addition, management was unable to provide documentation to support its conclusion that more conversions introduce more risk, which management illustrated with the vehicle integration being performed at Marshall that required more conversions of ProE into UGS MCAD because it had been initiated in UGS. Further, a count of the number of models being translated one way or the other does not adequately address the potential risk of data translation and integration. We also found risks inherent in standardization on any single tool solution. According to Dr. Jaroslaw Sobieski, who is considered an expert in Multidisciplinary Optimization Design and a colleague at NASA, “tools are constantly being improved so what do you do when a new or better tool comes to the market after you standardize?” He therefore suggested NASA use the best tool available at a given point in time, while at the same time keeping in-house proficiency with the continuous evolution of competing tools.

Additionally, the following figure illustrates an example that we found of a potential risk: the increased likelihood of data translation and integration errors due to a variance in the number of parts that may be encountered when translating models created with UGS MCAD software (NX) into ProE and vice versa.



Our review of documents showed that ProE MCAD software, for instance, has “Single Solid” modeling limitations that could increase model complexity with additional individually tracked components (parts) and assembly layers required to model the same item, as depicted in the figure above. Although the simplified Transfer Stage above could be accurately modeled when translated from NX MCAD to ProE MCAD, the extra 77 parts (156 parts minus 79 parts) needed to successfully model this solid item in ProE MCAD software must be individually identified and managed. Additional configuration management, storage resources, and computer processing power might be required for a ProE MCAD model, and if modifications to this model are needed for

integration or re-design, more work might be required to appropriately change every affected part. This additional complexity could increase the likelihood of one or more of the parts in the ProE model becoming inaccurate during translation and integration. On the other hand, more manual effort may be required using UGS NX when placing a pattern of features on a solid surface than might be required using PTC ProE. These translation issues underscore the critical need for a risk analysis.

In addition to considering the technical risks in translations to ProE, costs associated with translation, training, analysis, integration, verification, and problem resolution deserve objective analysis. Documents received so far indicate that just the translation of MCAD model files for the Ares booster first stage alone would cost more than \$9 million dollars. These risks, and others, are why it is critical for management to identify and document, in accordance with NPR 7150.2 and NPR 8000.4 requirements, all risks associated with the selection of ProE MCAD as a single standard for Marshall. Compliance with both of these NASA requirements is essential to sound program and project management.

Finally, we agree with management that Marshall had been using ProE, UGS, and many other MCAD tools for years before the decision to use ProE as the standard. However, we disagree with the assertion that the IEC team worked with all affected design groups to address stakeholder requirements, processes, and format and terminology concerns. As discussed in this memorandum, officials in the EV Branch stated that they were not included in the decision to establish ProE as the standard MCAD software for Marshall. The EV Branch is the primary user of MCAD tools at Marshall. However, documents prepared by the IEC Project Manager show that Marshall did not start to collect stakeholder requirements until September 2005, approximately 2 months after the MCAD selection was made. As a result, ProE was selected before stakeholder and operational requirements were fully identified and understood.

Recommendations, Management's Response, and Evaluation of Management's Response

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's Response. 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 current version levels) for new projects would significantly impact schedule and risk. Management also stated that the IEC team worked closely with existing projects that house UGS data in the Teamcenter PDM to confirm the level of support required to manage the data and that all groups but one indicated they have no need to retain active UGS data files and preferred to have their data archived rather than migrated to the Design and Data Management System (DDMS). The Associate Director, Marshall Space Flight Center, stated that remaining data would be

moved after an acceptable approach is established for transitioning the data and that any newly defined UGS initiative can use DDMS to manage its data.

Evaluation of Management's Response. Management's planned action is not responsive to the recommendation because management cannot support the assertion that allowing continued use of UGS PDM and MCAD software for new projects would significantly impact schedule and risk. We also disagree with management's assertion that the IEC team worked closely with existing projects. Interviews with Marshall engineering officials indicated that UGS PDM and MCAD software products were in use at Marshall long before the ProE selection, and the IEC Project Manager and Marshall engineering officials have not provided any RM data to support their assertion that continued use of UGS PDM and MCAD software would increase risk. The NASA guidance states that software requirements should be based on customer, user, and other stakeholder needs. Management's statement that only one group needs active UGS data files is not a substitute for analytical reasoning in accordance with NASA guidance. In this instance, the one group in question is the largest user group, so taking that group's needs into consideration is of significant importance.

Management's assertion that use of UGS PDM and MCAD software would significantly impact schedule and risk is also refuted by information provided by EV design engineers. They indicated that UGS products had been very effective and they questioned the reasonableness of eliminating UGS software. Documentation provided by the EV engineers indicated that UGS PDM and MCAD software was selected and used after a thorough technical evaluation process that included experts from across the Center. Furthermore, Marshall engineering officials excluded the use of UGS MCAD software on new design projects in 2005, the same time period that readers of "NASA Tech Briefs: Engineering Solutions for Design and Manufacture" voted UGS MCAD software the "2005 Product of the Year." NASA Tech Briefs are official NASA publications and have the largest circulation of any engineering magazine in the United States. EV design engineers also disagreed with excluding UGS products and stated that the unique capabilities of Teamcenter have been essential in meeting the schedule for the Crew Launch Vehicle System Requirements Review and would be key factors in meeting the schedule for the upcoming Crew Launch Vehicle System Design Review and Preliminary Design Review.

Management's assertion that the IEC team worked closely with existing projects to confirm the level of support required to manage the data is refuted by statements from officials in the EV Branch who said they were not given an opportunity to provide input into the decision to standardize MCAD software. Based on our review of 2005 Monthly Usage Reports, we determined that the EV Branch was the largest MCAD user group at Marshall. Documents prepared by the IEC Project Manager revealed that the IEC Project did not begin to identify stakeholder requirements until September 2005, approximately 2 months after ProE was selected as the standard MCAD software for new flight design projects. NPR 7150.2, paragraph 3.1, states, "requirements are based on customer, user, and other stakeholder needs and design

and development constraints. . . . It is important that there is ongoing customer validation of the requirements to ensure the products meet the customer needs.” Paragraph 3.1.1.2 requires that each project “identify, develop, document, approve, and maintain software requirements based on analysis of customer and other stakeholder requirements and the operational concepts.” We contend that Marshall increased program risks by establishing PTC’s MCAD as the standard without identifying and fully understanding user requirements, which could result in translation and integration problems.

As a result, we still believe that 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 allow design engineers to continue to use UGS PDM and MCAD software (at current version levels) for new projects, pending completion of actions in response to Recommendation 2.

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’s Response. The Associate Director, Marshall Space Flight Center, nonconcurrent with the recommendation. She stated that the use of the MCAD tools at Marshall, including ProE, was well established and understood, having been in use for more than 5 years and predating the selection of Windchill. The Associate Director further stated that Windchill risks had been assessed prior to our recommendations and additional assessments were not warranted, adding that further risk analysis of the Windchill and ProE implementation is not required as the requirements in NPR 7150.2 and NPR 8000.4 were not applicable. The Associate Director stated she will send a reminder to the appropriate official at Marshall to use NPR 7150.2, NPR 8000.4, and guidance from OCE for the selection of MCAD tools for major space systems.

Evaluation of Management’s Response. Management’s planned action is not responsive to the recommendation. We agree that Windchill’s risk was assessed—one of three PDM products assessed by the IEC Project in April 2002—but not in conjunction with ProE. The ProE selection was made approximately 3 years later and without the required risk assessment. Therefore, we believe that the implementation of the combined tools of Windchill and ProE should be assessed.

Management contends that NPR 7150.2 does not apply because “the PTC PDM development activity began in 2002 and [M]CAD tools were in use prior to the PTC PDM selection.” However, we noted that the 2002 PDM assessment and decision did not include the selection of a standard MCAD tool. In fact, the 2005 ProE MCAD selection marked the beginning of a new software acquisition, deployment, and maintenance activity. Since the effective date of NPR 7150.2 is September 27, 2004,

and documentation provided by Marshall engineering officials shows that ProE was selected in July 2005 as part of a separate business decision, NPR 7150.2 is applicable to the ProE standardization decision. Paragraph 2.1 covers software created or acquired by or for NASA, including commercial off-the-shelf (COTS), Government off-the-shelf (GOTS), modified off-the-shelf (MOTS), open source, reuse, legacy, and heritage software. In addition, NPR 7150.2 provides specific requirements for the acquisition and integration of software used in support of human space flight systems. "Support" may include detailed engineering drawings and modeling of physical components of systems that support human space flight. For example, flight safety decisions, including Flight Readiness of the Space Shuttle, depend on these MCAD tools for evaluating safety critical in flight contingencies. Therefore, it is clear that MCAD software support is directly linked to human space flight. Paragraph 2.3 states that NPR 7150.2 shall be applied to software development, maintenance, operations, management, acquisition, and assurance activities after its effective date of issuance, September 27, 2004.

A formal analysis of risks would have addressed some of the issues raised by some of the stakeholders. For instance, EV design engineers evaluated the capabilities of PDM and MCAD software of both UGS and PTC in an informal trade study during October 2006. Study results showed that Windchill had difficulties managing newer versions of UGS MCAD models. The same study showed that PTC's Windchill and ProE had limited or no capabilities in 10 of the 20 requirements criteria evaluated, while UGS's Teamcenter met all 20 evaluated criteria. The study also noted that Windchill and PTC's ProE had limited or no capabilities in the four requirements areas considered "Large Vehicle Systems Integration and Engineering (SE&I)/Development Show Stoppers." NPR 7150.2, paragraph 3.1.1.2, requires that each project "identify, develop, document, approve, and maintain software requirements based on analysis of customer and other stakeholder requirements and operational requirements."

OCE guidance, "Information for the Selection of Mechanical Computer-Aided Design (MCAD) Tools," states that many factors must be evaluated when selecting an MCAD tool, including complexity, interoperability, security, training, and intended use. Priorities have to be weighed to determine the most important factors on which to base a tool selection decision. Ultimately, an assessment of all appropriate factors will lead to cost and risk determinations that can help establish an overall value of the product under consideration.

NPR 8000.4, paragraph 2.2, outlines the evaluation process for identifying the risks (technical and programmatic) specific to a project. Project managers should identify individual risks and clearly describe those risks in terms of both the undesirable event the risk presents as well as the consequences of that event to the project. Project managers should develop a statement of risk for each identified risk. Risks should be summarized, and actions taken to mitigate or accept the risk should be documented. Therefore, it is imperative that a formal assessment and risk analysis be conducted for any MCAD software being considered as a standard for new flight system designs.

As a result, we still believe that 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.

We consider the recommendations to be unresolved. We request that Marshall reconsider its position and provide additional comments on both recommendations in response to this final memorandum by August 24, 2007.

We appreciate the courtesies extended to the staff during our ongoing review. Should you have any questions or would like to discuss this issue further, please call Mr. Vincent M. Scott, Procurement Director, Office of Audits, at 202-358-0546 or Mr. Larry T. Chisley, Project Manager, at 321-867-4073.

signed

Evelyn R. Klemstine

2 Enclosures

cc:

Chief Engineer

Chief Information Officer

Deputy Center Director, Marshall Space Flight Center

Associate Center Director, Marshall Space Flight Center

Director of Engineering, Marshall Space Flight Center

Manager, Marshall Engineering Programs and Systems Office

Manager, Marshall Integrated Engineering Capabilities Project

Scope and Methodology

We performed this review from October 2006 through January 2007. To accomplish our work, we visited Marshall and met with the Deputy Center Director and responsible officials in the Engineering Directorate for MCAD software selection and implementation. This review was performed in accordance with generally accepted government auditing standards.

We evaluated and compared the process for selecting MCAD software tools at Marshall with NASA engineering procedural requirements included in

- NPR 7150.2, “NASA Software Engineering Requirements,” September 27, 2004, which provides the minimal set of requirements established by the Agency for software acquisition, development, maintenance, operations, and management;
- NPR 8000.4, “Risk Management Procedural Requirements,” April 25, 2002, which provides the requirements and information for applying risk management to programs and projects, as required by NPR 7120.5C; and
- NPR 7120.5C, “NASA Program and Project Management Processes and Requirements,” March 22, 2005.

We also reviewed documentation included in

- IEC-Presentation-Systems Tools Analysis and Selection of PDM, April 16, 2002;
- IEC-Integrated Engineering Capability MCAD Transition Overview, September 26, 2005;
- IEC-Overview of Presentation, July 12, 2006; and
- Marshall Engineering Management Council Minutes, MCAD software transition and migration plans, briefings, management presentations, e-mails, and policies and procedures related to the selection of MCAD software tools.

Computer-Processed Data. We did not use computer-processed data to perform this review.

Internal Controls. To assess whether internal controls were adequate, we reviewed documentation used to identify customer, user, and other stakeholder needs in the development of software and operational requirements. We also reviewed documentation identifying technical and programmatic risks associated with the project to ensure PDM and MCAD software tools selected as the standard for space exploration vehicle design were assessed and whether risks were identified and analyzed in accordance with NPR 7150.2, “NASA Software Engineering Requirements,” September 27, 2004, and NPR 8000.4, “Risk Management Procedural Requirements,” April 25, 2002. We found that Marshall had assessed three PDM products and that the assessment resulted in selection of PTC’s Windchill as the primary PDM for Marshall engineering. However, we determined that the selection of PTC’s ProE as the standard MCAD for new flight

system designs was made without an assessment or risk analysis. We also determined that the selection process did not take into account customer and other stakeholder and operational requirements.

Prior Coverage. During the last 5 years, the NASA OIG has issued one report of particular relevance to the subject of this report: “NASA’s Acquisition Approach Regarding Requirements for Certain Engineering Software Tools to Support NASA Programs” (Assignment No. S-06-012-00, August 23, 2006). Unrestricted reports can be accessed over the Internet at <http://www.hq.nasa.gov/office/oig/hq/audits/reports/FY07/index.html>.

Management's Comments

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



April 10, 2007

Reply to Attn of:

DE01

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

FROM: Associate Director, Marshall Space Flight Center (MSFC)

SUBJECT: Comments on the Draft Memorandum on MSFC's Approach to
Establishing Product Data Management and Mechanical Computer-Aided
Design Software Tools as Standard Center-Wide
(Assignment No. S0700100)

We have reviewed the subject draft report and our detailed comments are enclosed. 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

Enclosure

Mission Success Starts with Safety

**Marshall Space Flight Center (MSFC) Response to the OIG
Draft Memorandum on MSFC's Approach to Establishing
Product Data Management and Mechanical Computer-Aided
Design Software Tools as Standard Center-Wide
(Assignment No. S0700100)**

Specific Comments

(1) Page 1, para. "After our August report...":

Decisions to use the Parametric Technology Corporation (PTC) Product Data Management (PDM) tools at MSFC were made in 2002 based on trades of three different vendor products including PTC and UniGraphics Solutions, Inc. (UGS). The reason for performing the PDM trade and selection in 2002 was to consolidate engineering data in one location, provide tighter configuration control while improving efficiency, security, and consistency of data used in the design and development activities at MSFC. Since the UGS and PTC PDM products both support multiple Computer-Aided Design (CAD) formats, including UG NX and Pro/E Mechanical Computer-Aided Design (MCAD) data, a decision for either PDM did not dictate a specific MCAD tool to be used. In fact, the strategy to use the selected MSFC PDM (PTC's Windchill) as the engineering data hub to manage UGS MCAD data along with any Pro/E or other CAD data being used at the Center has not changed since the PDM selection in 2002.

The PDM and MCAD selections in question were made (3) years apart in completely separate decision processes with unique business drivers. The risks are separate and unique as well. In 2002, when PTC's PDM (Windchill) was selected as the data management system, the MSFC UGS PDM was primarily used in one area of MCAD where it had limited data storage, no configuration management, no embedded processes, and no secure data transmission. In fact, the MSFC UGS PDM was more akin to a shared data server with limited iteration control. Still other designers at that time used local hard drives and network drives to store CAD data along with insecure e-mail and File Transfer Protocol (FTP) transmissions to distribute and share CAD models. Therefore, the real risk to MSFC was in doing nothing.

In 2005, when MSFC decided to use Pro/E for the majority of its in-house design efforts, the Center already had experienced years of using many different MCAD tools, including UG NX and Pro/E. Because MSFC had several MCAD packages, we routinely required CAD translations or redrawing of MCAD models even internally between design organizations as well as between MSFC and other NASA Centers. Design practices, processes, and modeling standards varied from one internal design team to another.

Page 2

(2) Pages 1-2, para. "We found that Marshall...":

Contrary to the stated position, the MSFC Integrated Engineering Capabilities (IEC) Team has gone to great lengths to establish and maintain customer and stakeholder requirements. When the IEC initiative began in 2002 a separate engineering team, Integrated Engineering Solutions (IES), was established to capture engineering processes and terminology that included membership from a broad cross-section of engineering disciplines throughout MSFC. When the IES group disbanded in 2004 the IEC team increased its focus on capturing design team requirements, processes, and desired data formats along with Engineering policy to form requirements that were vetted and validated by the design groups affected prior to implementation. Additional efforts to improve stakeholder involvement include an ongoing weekly IEC stakeholders meeting open to all interested parties to address concerns, establish requirements for new areas of development, and validate implementation approaches.

Page 2

(3) Page 2, para. "Marshall's Selection of MCAD...":

At the time of the PDM selection in 2002, NPG 7120.5A, "NASA Program and Project Management Processes and Requirements" was the approved procedure applicable to projects that Provide Aerospace Products and Capabilities (PAPAC) as identified by the governing Program Management Councils (PMC). The MSFC Center PMC and IEC project management never levied NPG 7120.5 on the initiative because it was seen as an infrastructure enhancement and not a PAPAC project. Additionally, looking at the current version (NPR 7120.5D, dated March 6, 2007) it is clear that the requirements are "applicable to current and future space flight programs and projects" which again excludes the IEC PDM and MCAD initiatives, as they are not space flight initiatives. Also, NPR 7150.2, "NASA Software Engineering Requirements" did not exist in 2002 as it was initially approved on September 27, 2004. However, even though these requirements are not applicable, the IEC project does track Design and Data Management System (DDMS) risks with clear criteria, likelihood, consequences, and mitigation strategies identified.

Page 4

The following excerpts from NPG 7120.5A, NPG 8000.4, and NPR 7150.2 support our position that the requirements are not applicable.

NPG 7120.5A, paragraph 2.2, states, "This document provides the basic processes and requirements for the life cycle of all programs and projects. It shall be used specifically for programs/projects that provide aerospace products or capabilities, i.e., provide space and aeronautics, flight and ground systems, technologies, and operations. It is not required but may be used for other projects, such as nonflight infrastructure, Construction of Facilities (CoF) Small Business Innovation Research (SBIR), or Research & Analysis (R&A) projects."

NPG 8000.4, paragraph 2.2, states, "This document provides the basic processes and requirements for the planning and implementation of the

RM process through the life cycle (see Appendix A, Glossary) of all programs and projects. It shall be used specifically for programs/projects that provide aerospace products or capabilities - i.e., flight and ground systems, technologies, and operations for space and aeronautics. It is not required for other projects (such as research conducted under the Generate Knowledge Crosscutting Process or training and education conducted under the Manage Strategically Crosscutting Process); however, the RM concepts and practices described within this document may be beneficial to other projects, so their application should be considered."

In addition, NPR 7150.2, paragraph 2.3, states, "This NPR shall be applied to software development, maintenance, operations, management, acquisition, and assurance activities started after its effective date of issuance" (September 27, 2004). The PTC PDM development activity began in 2002 and Pro/E CAD tools were in use even prior to the PTC PDM selection.

(4) Page 3, Assessment and Risk Analyses Section, para. "In April 2002...":

The reason no primary MCAD tool was identified in 2002, at the time the PTC PDM (Windchill) was selected, is that the decisions are independent as both UGS and PTC PDMs are designed to support multiple MCAD formats.

(5) Page 3, Assessment and Risk Analyses Section, para. "Subsequent to the selection...":

The selection of a PDM at MSFC in 2002 was centered on establishing a single engineering data management system to improve the accuracy, availability and control of design and project data.

It is an incorrect assertion and inaccurate to suggest that MSFC engineering officials "limited UGS MCAD users to technically obsolete version levels." To ensure compatibility between the current deployed version of the MSFC Windchill environment and both UG and Pro/E MCAD models, the IEC Project requested that neither UGS or Pro/E MCAD applications be upgraded until the newer versions could be supported by the data management system. The approach recommended by the IEC team to limit upgrades of all MCAD packages until compatibility with the data management system can be validated is consistent with good information technology (IT) architecture practice as outlined in guidelines contained in "Information for the Selection of Mechanical Computer-Aided Design (MCAD) Tools." The deployment of new applications or upgrades to existing applications that are not compatible with the IT architecture adds risk and reduces functionality and efficiency. Additionally, a new release of software does not automatically render the previous versions technically obsolete. Many aerospace companies are still using the previous version of the UGS MCAD software successfully.

(6) Pages 3-4, Assessment and Risk Analyses Section, para. “During March 2005...”:

Page 5

The rebalancing of UGS and ProE MCAD was presented to the Engineering Management Council (EMC) where managers from every department and lab heard all sides of the issue, and evaluated the impacts, including risk. The EMC decided to proceed with the transition. The decision of the EMC was not well received by all and an appeal was made to the NASA Office of the Chief Engineer (OCE). The NASA Chief Engineer enlisted the help of the NASA Engineering Safety Center (NESC). The NESC made several recommendations and MSFC Engineering took steps to address those recommendations. IEC did not make any recommendations or decisions to move toward Pro/E as the in-house MCAD tool.

(7) Page 4, Assessment and Risk Analyses Section, para. “Officials in the Marshall...” :

Page 5, last paragraph

It is true that data translation and integration of disparate CAD models is not desired and is a significant factor in the determination of design tools that should be used. This was one of the significant drivers behind the decision to move toward Pro/E for future in-house design work in the first place since most other NASA Centers MSFC interacts with were using Pro/E as well as contractors for current ORION and ARES design efforts. The specific case referenced in the memo concerning integration with the first stage contractor is the exception not the rule. In contrast, the current vehicle integration being performed at MSFC was initiated in UGS MCAD that requires integrating the MSFC Upper Stage (Pro/E), JSC Crew Exploration Vehicle (Pro/E), J2-X engine (Pro/E), and First Stage (I-DEAS). This has required more conversions of Pro/E into UGS MCAD than vice versa and, hence, introduces more risk. It has also rendered integrated models that are unusable for Kennedy Space Center design groups using Pro/E.

It is important to note that MSFC has always had translation issues to contend with because historically, we were in the minority of NASA Centers using UGS MCAD.

(8) Page 4, Assessment and Risk Analyses Section, para. “In addition, officials...” :

Page 6

This description of events implies that MSFC was only using UGS MCAD tools before the 2005 decision to use Pro/E MCAD for in-house design work was made. Actually, while MSFC had been predominately using UGS MCAD products it was not the only MCAD tool in use. MSFC had been using Pro/E and UGS MCAD tools, along with many others, for years prior to the decision. Further the decision to use the Pro/E application as the primary MCAD tool beginning in 2005 was not an attempt to eliminate the UGS products but rather rebalance the use to our current needs. We continue to use UGS and Pro/E MCAD tools as necessary to satisfy design needs.

As stated earlier, the IEC team has continued to work with all affected design groups including those in the Spacecraft and Vehicle Systems Department to address stakeholder requirements, processes, format, and terminology concerns. Despite the IEC team's

effort to reach out to all affected design groups, some of the UGS CAD core users have been unwilling to participate in discussions.

Recommendations

The Marshall Center Director should direct the Marshall Director of Engineering to

- 1. Suspend all activities associated with the archiving and migration of data from Teamcenter to Windchill, and allow design engineers to continue to use UGS PDM and MCAD software (at current version levels) for new projects; and**

MSFC Response: Non-Concur. We appreciate the concerns raised by this memo and feel that we have addressed them through previous meetings, discussions and correspondence with the EMC, OCE, and NESC. We firmly believe that it is in the best interest of MSFC Engineering, NASA and the Crew Launch Vehicle program to have applications that are compatible with the Exploration program. Additionally, most of MSFC Engineering has made the transition with little difficulty and the majority of the transition is complete. 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 current version levels) for new projects would significantly impact schedule and risk. Therefore, MSFC non-concurs with this recommendation. The IEC team has worked closely with existing projects that house UGS data in the TeamCenter PDM to confirm the level of support required to manage the data. All but one group have indicated that they have no need to retain active UGS data files and all but the one group preferred to have their data archived rather than migrated to DDMS. The remaining data will be moved after an acceptable approach is established for transitioning the data. Any newly defined UGS initiative can utilize DDMS to manage their data.

- 2. 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 guidance from Office of the Chief Engineer's for the selection of MCAD tools for major space systems.**

MSFC Response:

Non-Concur. The use of the MCAD tools at MSFC, including Pro/E, is well established and understood having been in use for more than five years and predating the selection of Windchill PLM tools. The Windchill PLM risks have been assessed prior to these IG recommendations and additional assessments are not deemed warranted. Further risk analysis of the Windchill and Pro/E implementation is not required as the requirements in NPR 7150.2 and NPR 8000.4 were not applicable (see Specific Comment 3 above). However, we will send a reminder to the appropriate officials at MSFC to utilize NPR 7150.2 and NPR 8000.4, and guidance from Office

of the Chief Engineer's for the selection of MCAD tools for major space systems.

Corrective Action Official: ED01/Director of Engineering
Corrective Action Closure Official: DE01/Robin Henderson
Projected Closure Date: September 5, 2007