Honeywell

Geometric Qualification of Production Parts

Federal Manufacturing & Technologies

J. A. Bradley
Department Q-11

KCP-613-7047

Distributed September 2005

Final Report on ADAPT 706404

Prepared under prime contract DE-ACO4-01AL66850 for the
United States Department of Energy

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process or service by trade names, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

All data prepared, analyzed and presented has been developed in a specific context of work and was prepared for internal evaluation and use pursuant to that work authorized under the reference contract. Reference herein to any specific commercial product, process or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation or favoring by the United States Government, any agency thereof or Honeywell Federal Manufacturing & Technologies, LLC.

Printed in the United States of America.

This report has been reproduced from the best available copy.

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, Tennessee 37831; prices available from (865) 576-8401, FTS 626-8401.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal, Rd., Springfield, Virginia 22161, (703) 487-4650.

A prime contractor with the United States Department of Energy under Contract Number DE-AC04-O1AL66850

Honeywell Federal Manufacturing & Technologies
P.O. Box 419159
Kansas City, Missouri, 64141-6159

Honeywell

KCP-613-7047
Distribution Category UC-42

Approved for public release; distribution is unlimited.

Geometric Qualification of Production Parts

J. A. Bradley
Department Q-11

KCP-613-7047

Distributed September 2005

Final Report on ADAPT 706404
J. A. Bradley, Project Leader

Contents

Section *Page*

Abstract 6

Summary 6

Discussion 7

Scope and Purpose 7

Activity 7

GQPP Project Requirements and Selection 7

Evaluation and Conclusions 8

Accomplishments 9

Abstract

Computer Aided Design (CAD) is a commonly utilized software tool to conceptualize and create the part designs that are then used as input for product definition, or for the manufacture of production parts within commercial industry and, more specifically, at the Kansas City Plant (KCP). However, data created on CAD systems is, at times, unable to regenerate within the originating CAD system or be shared or translated for use by a dissimilar CAD system. Commercial software has been developed to help identify or qualify these difficulties that occur in the usage of this data. This project reviewed the different commercial software packages available for the activity of qualification and made recommendations for availability and use in the design processes at the KCP prior to the release of the product definition.

Summary

To facilitate sharing of design data, the National Nuclear Security Administration (NNSA) selected a primary CAD system, Pro/ENGINEER from PTC. Other CAD and Computer Aided Manufacturing (CAM) systems are used for other functions such as analysis, manufacturing, etc., within the KCP. However, at times in the development of the product definition, associates at the KCP have not been able to use the files containing the product model in Pro/ENGINEER or the translated product definitions in the target CAD or CAM systems.

Initial efforts to determine the issues causing this condition identified the complex algorithms used by CAD and CAM systems to define the product models. These product models, also known as part models, are the definitional basis for all operations within a CAD system including the generation of a drawing. Differences in definition computations, changes in the algorithms, and other factors resulted in non-released product definitions that are not supported by all systems all of the time. A typical example of this type of issue is found in the geometry of a product model definition. Although well-connected logically, two adjacent surfaces have gaps and overlaps along their common edge. In an effort to mitigate the impact these issues had on the definition development process, a project team with members from the KCP and Sandia National Laboratories, Albuquerque NM, identified and tested commercial, off-the-shelf (COTS) software packages that purported to address the causes of these issues in Pro/ENGINEER data.

Three COTS software packages that did not alter the native CAD definition when evaluating the product model were identified. Over the course of our evaluation, one of these software packages was purchased and then incorporated into our primary CAD system for design, Pro/ENGINEER. This integration provides designers with a large amount of feedback to use when determining the underlying cause of usage issues.

Discussion

Scope and Purpose

Prior to the initiation of the Geometric Qualification of Production Parts (GQPP) project at the Kansas City Plant (KCP), issues with the CAD geometry representation of the product model would occasionally arise during the creation the product model. These issues would, at times, prevent a CAD system from importing and displaying a CAD model regardless of the CAD system in which it was created. Upon investigation, it was determined that the issues are usually dependent on the complexity of the models being created and the underlying mathematical representations being used to define the model. These geometry issues occur with all CAD systems and with all users of the CAD systems regardless of the methodology they employ to create the product model.

It was determined that there were two primary goals of this project:

- Identify tools that will assist designers by evaluating the CAD geometry representation of the product model that has issues and provide feedback to the designer regarding the underlying causes of the issue(s)
- Design a process that can be used when the issues occur

Activity

GQPP Project Requirements and Selection

KCP and Sandia work closely together in the definition of parts for the NNSA and share a large amount of definitional data for the manufacture of those parts. Geometry-based issues occur regardless of the software used, the site generating the product model, the designer, or design methodology. Therefore, an optimal solution would be able to be employed at both sites.

Three software packages were identified as potential candidates. All of them evaluated the CAD representation of the product model in native format, without alterations to the original product model, and notified the designer of any issues that might prevent subsequent use of the product model. These software packages were: ModelCheck from the RAND Corporation, DesignQA and GeomQA from Prescient Technologies, and CAD/IQ from International TechneGroup, Inc (ITI-OH). During the course of the evaluation, ModelCheck was purchased by PTC and subsequently tightly integrated with the Pro/ENGINEER software. Additionally, Prescient Technologies dropped support for their software and had to be eliminated from the evaluation.

Evaluation and Conclusions

The KCP and Sandia user communities evaluated the remaining software packages and determined that the optimal and most insightful feedback for the user was provided by the ModelCheck tool as implemented by PTC in their Pro/ENGINEER CAD software. The primary limitations of this tool are that it only evaluates the Pro/ENGINEER native format product model and not any of the alternate output formats, and it is not independent of the algorithms that are used to create the product model.

CAD/IQ, from ITI-OH, while not as tightly integrated with the Pro/ENGINEER CAD software, is capable of evaluating a wide range of output formats from multiple CAD systems and is completely independent of the Pro/ENGINEER software algorithms. Additionally, it evaluates product models for a wider range of problem causing geometry conditions.

It was determined that the user communities at the KCP and Sandia will use ModelCheck when creating product models in Pro/ENGINEER to ensure that they adhere to the appropriate product model creation processes. It is then up to each individual to evaluate the geometry of the native format Pro/ENGINEER product model to ensure that there are not any problems with the model. CAD/IQ is also available to further evaluate the geometry of the product model (native format Pro/ENGINEER) or any other supported formats.

Accomplishments

The following are the major accomplishments for the KCP's GQPP project:

- Alignment of product model creation and geometry evaluation using the primary CAD system at the KCP and Sandia
- Selection of a toolset to provide identification of issues during the creation of the product model data in our primary CAD software for design
- Creation of a process to implement the usage of this toolset

While there are significant cost and time savings associated with the accomplishments from the GQPP project, the primary benefit for the KCP lies in the coordination and implementation of this toolset at the KCP and Sandia. Designers at either site are able to utilize a toolset that provides direct identification of issues. These issues had, in the past, resulted in significant time and effort spent trying to manually determine the source of the issue, which greatly impacted the usage of the product model under development. Finally, as a result of the GQPP project, the usability of the product models as input to production has increased.