

Title: A DFMA Cost Information Management System at Whirlpool

Jason Lynn – Whirlpool Corporation

Chris Holt – Convergence Data Services

About Whirlpool Corporation

Whirlpool Corporation has grown over the last 100 years from its origins as a Midwestern U.S. company to the major appliance industry's global leader. Today, the company leads the \$120 billion global home appliance industry with 2010 sales of more than \$18 billion. Its products are sold in more than 130 countries around the world and the company employs more than 68,000 people worldwide

Whirlpool Corporation manufactures appliances across all major categories, including fabric care, cooking, refrigeration and dishwashers, and has expanded into adjacent businesses, such as appliances, garage organization, laundry organization, kitchen cookware, cutlery and water filtration products. Whirlpool brands are Whirlpool®, Maytag®, Kitchenaid®, Jenn-Air®, Amana®, Bauknecht®, Brastemp®, Consul® and Gladiator®

About Convergence Data Services

Convergence Data Services is a software and content services company that provides a much better way to manage parts and the items that are commonly associated with parts including: documents, drawings, people, programs, or suppliers.

Convergence has created a novel approach that makes it very easy for companies to structure their data and to create and maintain relationships between critical pieces of information. The solution is DFR™ (Design for Retrieval™). DFR uses adaptive database technology to manage complex relationships between items. DFR makes it easier for the non-IT professional to set up data models for part information. Convergence's SmartFind™ search tool provides multiple ways to query complex engineering data to quickly find exactly what you need quickly, leveraging the data model created by DFR. Together both solutions can help eliminate today's challenge of finding the right item, using preferred parts and duplication.

About Jason Lynn, Engineering Manager, Competitive Cost Analysis at Whirlpool

Jason Lynn works as an Engineering Manager with Whirlpool Corporation. He has just finished a two year assignment to manage a cost modeling group in China associated with competitive analysis. Prior to that, he worked to establish and develop the Cost Modeling discipline at Maytag and later with Whirlpool. In this roll he has developed cost models with suppliers, provided cost visibility on new

products, and identified costs of competitive products. Before Maytag, he spent 10 years in the quality control area of manufacturing for Arvin Automotive and Carrier Corporation in Indiana. Lynn holds a BS in Mechanical Engineering from Brigham Young University and an MBA with a focus on finance from Indiana University.

About Chris Holt, Engineering Manager and Chief Architect at Convergence Data Services

Chris Holt led the development team and worked closely with Jason and the Whirlpool team over the course of the past year. Prior to that, he contributed to the project as an individual contributor while enhancing Convergence's core software platform. Chris has 12 years of software development experience, 6 years working for Convergence Data Services where he currently serves as both an Engineering Manager and Chief Architect. Chris holds a BS in Computer Science from Worcester Polytechnic Institute with minors in both Business Management and Electrical Engineering

Introduction

Whirlpool Corporation has significantly scaled their use of DFMA cost estimating tools in recent years. Today, there are several different teams and hundreds of DFMA users involved in cost modeling at Whirlpool. They support critical business functions including benchmarking, cost modeling for new and existing products, and supplier collaborations to name a few. As a result, they have created 1000's of DFMA cost models and began to have difficulty with managing this data as well as in distributing it to large engineering groups and procurement teams for use in day-to-day business decision making.

Whirlpool realized that the growth of the team and the increase in usage of cost data within the business was beginning to stress the system. They needed a way to better develop, manage, and reuse DFMA data they generate. As activity increased, they also needed a better reporting tool to help with distributing this information to end users in purchasing and engineering. They also needed to insure cost models were created correctly and consistently following standard procedures and use of DFMA libraries across international locations. Additionally, they had to more easily access this data and to conduct comparisons at different levels for components, assemblies and entire products. And lastly, they needed a way to batch update past cost models against updated DFMA libraries.

This paper describes how Whirlpool and Convergence Data worked together to build a more scalable DFMA architecture. This solution can publish validated DFMA data into a single database. It insures the correct DFMA libraries are used and validates the DFMA files were created following global cost modeling standards. A search and reporting tool is now used to effectively disseminate this data to thousands of users today. Internally, Whirlpool refers to this system as CIM or Cost Information Management.

Original Competitive Costing at Whirlpool

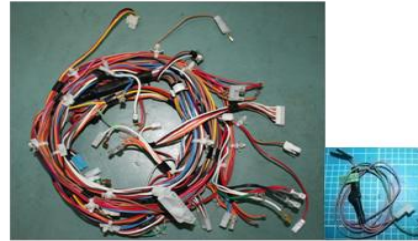
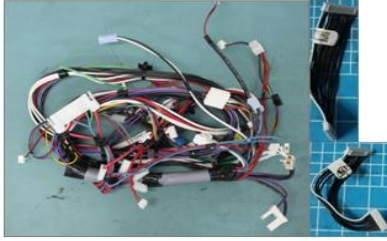


The CCA or Competitive Cost Analysis group was set up in 2008 to provide competitive data to the Engineering and Procurement departments of Whirlpool. The goal was to provide a standard teardown process with repeatable results. The process heavily relies on DFMA for the labor and component calculations. The group started with only 4 members doing 8 competitive reports and has grown to 64 members generating 250 reports annually.

At the same time, the Cost Modeling function grew in other areas around the organization leading to a global Cost Modeling group working with Engineering and Procurement to identify cost early in a development project. The Cost Modeling tool was also under constant change as more accuracy in the results was needed by the CCA and Global customers. Cost Modeling processes were standardized and communicated globally. New cost libraries were developed and updated on a regular basis to keep up with changes in raw materials and processing costs.

Growth Creates Opportunity and Challenge

The growth and popularity of the CCA data caused a number of issues directly related to the complexity of the traditional approach to completing analysis. As illustrated in Exhibit 1 below, cost reports required the generation of hundreds of cost models, management of photos, assembly of comparison Excel sheets, the assembly of information into PowerPoint report outs, and distribution to business users.



Whirlpool	Designed Cost	Competitor	Designed Cost
AWG 12 (3.31mm ²) 600V @ 8877.9mm	\$12,547	AWG 14 (2.08mm ²) 600V @ 8463.8mm	\$16,223
AWG 14 (2.08mm ²) 600V @ 2949.2mm		AWG 16 (1.31mm ²) 600V @ 4252.1mm	
AWG 18 (0.823mm ²) 600V @ 18927.4mm		AWG 18 (0.823mm ²) 600V @ 25795.4mm	
AWG 20 (0.518mm ²) 600V @ 3030.0mm		AWG 20 (0.518mm ²) 600V @ 25926.7mm	
AWG 22 (0.326mm ²) 600V @ 12756.3mm		AWG 20 (0.518mm ²) 300V @ 3201.7mm	
AWG 22 (0.326mm ²) 300V @ 2525.0mm			
Total wire length: 49065.8mm		Total wire length: 67639.7mm	
Strands @ 72		Strands @ 68	
Terminals @ 122 (including terminal block)		Terminals @ 103 (including terminal block)	
Housings @ 25		Housings @ 23	
Splices @ 5	Splices @ 5		
Accessories @ 48	Accessories @ 62		
Others	\$0.029	Others	\$0.602
Labor	\$0.910	Labor	\$2.410
Total	\$13.486	Total	\$19.235
Designed Cost Delta (WHR Designed vs. Competitor Designed)	\$5,749		
Detail list in page 66			

--Report Overview--

Sub-System Cost Gaps

Observations

Pictures with Cost Details

Process standardization, documentation, and training helped assimilate new hires and provided some level of productivity improvement, but significant opportunity still remained. More specifically, there was still a need for:

- A way to easily find cost models for reuse
- Ensuring models where using the correct, current libraries
- More easily update groups of cost models as libraries updated
- Reducing the manual effort required to assemble reports
- Easier access for business users

Leveraging Existing Capabilities to build a CIM Solution at Whirlpool

In short, Whirlpool needed better technology support to mitigate the scalability issues and meet future demand for more accurate and available cost data. At the time, Whirlpool had already made investments in some related engineering technologies including BDI's DFMA cost estimate tools, PTC's PDM solutions and Convergence Data's part classification and search tools. Whirlpool looked at other cost estimating technologies in the market and realized there was no existing capability to meet their scalability requirements, so they looked to better integrate what they already had.

Key components of this new integrated CIM solution that required development included a DFMA validation tool, DFMA publishing tool, DFMA file storage capability, DFMA Refresh tool and a more dynamic cost reporting capability. Working closely with Convergence Data Services, Whirlpool set off to build this system over a 2 year period.

DFR Part Classification and Database – Augmented for DFMA Costing Data

One of the main components of this new cost information management architecture is a solution called DFR or Design for Retrieval provided by Convergence Data Services. About three years prior to the CIM project, Whirlpool had built out an enterprise taxonomy using DFR that supports the components and products they design, manufacture, and buy from suppliers. They already had in place rich part metadata on most of their parts including material, dimensional, and performance characteristics in the DFR database. Whirlpool was able to extend this data model to capture additional information produced by the DFMA estimating tools including costs output fields, cost input fields, manufacturing process information, and library references.

A custom publishing tool was developed by Convergence to validate and publish DFMA data to the DFR database. The validations checked each DFMA analysis to make sure it was complete and correct prior to publishing DFMA results. This helped Whirlpool insure DFMA files were completed following a standard process. As part of the publishing process, all associated DFMA files including library files are moved to the production PDM Windchill repository. Windchill is a PLM software solution used to help streamline the product development process and is used by Whirlpool.

CIM SmartFind Search and DFMA Reporting Tool

Prior to having a browser based search tool, Whirlpool would have to view past competitive costing results in a PowerPoint document. Today using CIM SmartFind, Whirlpool engineers can easily find the exact part or assembly they are most interested in and compare designs with competing designs including their DFMA should costs. When interrogating the cost drivers of a competing design, Whirlpool engineers can view multiple images and associated DFMA data of a competitive design to help understand cost differences and areas to achieve cost advantages. CIM SmartFind has now become the primary tool for engineers at Whirlpool to access DFMA cost estimating data and create their own personal reports. CIM SmartFind makes it easy to compare competing designs side by side, at any level

in the product structure. This is done via cost roll-ups based on teardown codes. Each level of a product structure is assigned a teardown code, which makes it easier to facilitate side by side comparisons of competing designs, especially at higher levels in the product structure. (as shown in the following example)

CIM SMARTFIND
BY CONVERGENCE DATA SERVICES

Home View Configuration Release Notes Help CIM Help

Logged in as: **choit** Logout

B550C ← See where your are in the product structure and navigate

Competitive Part Comparison: Module System to Sub-System

Scoped by project: FC.Asia.2011.36_WHR B550C

Drill Down Product Structure

See Cost Differences

	Item Number	DFM Designed Materials Cost	DFM Designed Labor Cost	Item Number	DFM Designed Materials Cost	DFM Designed Labor Cost	Delta
Cabinet	MSV1021	CNY81.5071	CNY0.5831	MSV1032	CNY77.0867	CNY0.765	CNY4.2385
Top And Lid	MSV1022	CNY53.9226	CNY0.2084	MSV1033	CNY48.2233	CNY0.2193	CNY5.6884
Controls	MSV1023	CNY134.667	CNY1.2745	MSV1034	CNY93.6382	CNY0.3958	CNY41.9075
Hydraulic System-Inlet	MSV1024	CNY17.1197	CNY0.2459	MSV1036	CNY17.2642	CNY0.3198	CNY-0.2184
Hydraulic System-Outlet	MSV1025	CNY20.716	CNY0.1632	MSV1037	CNY20.3521	CNY0.2722	CNY0.2549
Drive System	MSV1026	CNY200.7823	CNY0.5554	MSV1038	CNY177.7343	CNY0.6301	CNY22.9733
Wash Unit	MSV1027	CNY159.3373	CNY1.13	MSV1039	CNY150.2907	CNY1.3145	CNY8.6621
Hydraulic System-Recirculation	MSV1028	CNY0	CNY0	MSV1040	CNY0	CNY0	CNY0
Ventilation	MSV1029	CNY0	CNY0	MSV1041	CNY0	CNY0	CNY0
Packaging	MSV1030	CNY45.6854	CNY0.3346	MSV1042	CNY40.1063	CNY0.1991	CNY5.7146
Documentation	MSV1031	CNY0.655	CNY0.1016	MSV1043	CNY1.765	CNY0.1751	CNY-1.1835
Whirlpool - B550C	B550C				CNY597.5771	CNY4.3166	CNY78.8948

View Part/Assembly Details

Green - Negative Deltas indicate Whirlpool cost advantage

SmartFind® 3.6.986.0 Oracle WP_5 - LiveUpdate Convergence Data Services Copyright © 2006-2012

CIM SmartFind – Whirlpool’s Cost Information Management Search and Reporting Tool by Convergence Data Services. Example of cost rollup comparison between two products including images.

PTC’s Windchill to Support File Storage – Promote Re-Use

In the past, the hundreds of cost models, images, libraries, and other files related cost reporting were stored in different places including: network drives, vaulting repositories or individual hard drives. As one can imagine, easily finding and reusing existing DFMA files was a challenge.

To address these file management challenges, Whirlpool looked to leverage their new PDM solution called Windchill from PTC. When a DFMA analysis was ready for formal publishing, the associated files are all moved to a more formal directory structure that is maintained by Windchill. Each one of these files is indexed and the file URL’s become available in the CIM SmartFind search solution.

Today, when an engineer searching in CIM SmartFind comes across a cost analysis they are interested, it’s now very easy to retrieve all of the associated DFMA files. This has significantly reduced the administration time of trying to find the latest DFMA files and more importantly having to recreate them to perform additional costing analysis.

Refreshing Costing Data to Keep Current

The last remaining problem to solve for this CIM solution was to provide Whirlpool the ability to more easily update past DFMA cost analysis with the latest DFMA libraries. DFMA libraries contain costs that are dynamic including raw material costs, labor rates and machine tool rates that can change considerably over time. The DFMA library costs can have a significant impact on the overall DFMA product cost estimates, so it's important they are current when doing comparisons.

In the past, Whirlpool would have to invest significant amount of time updating past DFMA analysis against the latest DFMA libraries...when you have 1000's of cost models, this becomes a real problem. To address this issue, a refresh capability was built into the DFMA manager module in DFR, now Whirlpool engineers can batch update multiple DFMA files in a more automated process against the most recent DFMA libraries. Whirlpool is in the process of rolling out this capability today.

Conclusions – Deployment Strategy and Benefits of the new CIM solution at Whirlpool

Whirlpool deployed the new CIM solution in the beginning of 2012 across its major divisions. Jason Lynn has led the training efforts, traveling the world to different Whirlpool locations. The new CIM solution has been well received with usage scaling significantly. Since launch, the tool has averaged 3-4 visits per trained employee per month. The database contains over 160 teardown projects representing over 250 Whirlpool and competitive units. There are over 125,000 cost models and 250,000 pictures from the teardowns. The CIM SmartFind reporting tool is now used by a large number of Whirlpool engineering staff around the globe, allowing them to do their investigations and create their own custom reports based on what they find, something that could not have been easily done in the past.

Today, Whirlpool has:

- Deeper and more dynamic search capability

Searches and comparisons can be as broad as a Whirlpool product versus a competitive product or as specific as a Whirlpool part versus a competitive part. Product and cost detail's can be obtained from any level by simply selecting the part or sub-assembly.

- Consistent and fair comparisons

All of the past data will be recalculated with current libraries making all comparisons focus on design differences (material and manufacturing).

- Global accessibility

The user will be able to search the CIM SmartFind database from wherever they are. The CIM SmartFind tool will be accessible to anyone within the Whirlpool network.

- Data specific to the task

Users are able to customize searches to only see what is relevant to the task at hand.

As cost modeling and the use of cost knowledge continues to evolve at Whirlpool, the CIM solution will evolve to provide the type of productivity that is expected of well managed information technology tools.