



# CASE STUDY



PolyWorks 3D metrology software helps oil field equipment manufacturer cut motor component inspection time in half



Company overview



## Weatherford

Weatherford International Ltd. (NYSE: WFT) is one of the world's largest and most dynamic oilfield service companies. Headquartered in Houston, the company employs more than 34,000 people worldwide, operating in more than 710 locations and in more than 100 countries around the world. The company's Edmonton, AB, Canada facility designs and manufactures two products for petroleum production operations—progressing cavity pumps used in the production of oil after the well is drilled, and fluid power sections.

## PolyWorks

Total Point Cloud Inspection and Reverse-Engineering Solution



# Situation

To meet the demands of the booming world oil and gas drilling industry, Weatherford International Ltd., one of the world's largest oil field service companies, has ramped up production and with it the need to improve the efficiency of their inspection operations.

Weatherford products support operations by major petroleum producing companies throughout the world. The company's Edmonton, Alberta facility designs and manufactures two products for petroleum production operations—progressing cavity pumps used in the production of oil after the well is drilled, and fluid power sections. The fluid power section is the motor that provides the power to drill the well. To help improve production efficiency, the company sought a new, more efficient way to inspect fluid power sections, which have a very complex geometry and are difficult to inspect using traditional methods.

In the past, the company had established a procedure that required four people—one from manufacturing, one from quality control and two from engineering—to dimensionally inspect the fluid power sections after machining. The inspection process for these large, helically curved components—some nearly 20 feet in length—took approximately one hour to gather the dimensional data and manually compare it to the original design as created in CAD software. Machine offsets were relayed to the shop floor, where changes were made in the machining process. Another section of the same component was machined, and the inspection process was repeated on this section to determine if the corrections had improved the dimensional accuracy of the workpiece.

*This was a very time consuming process. Plus, we had to restrict our inspection operations to normal business hours since that was when the engineering department was available to compare the measured geometry with the CAD drawing.*

**Wayne Pilgrim**  
Weatherford Senior  
Project Engineer



Fluid power section

# Solution

## Aiming for Efficiency

In 2005, the company re-evaluated its approach to inspecting these parts with the object of finding a more efficient method of gathering and analyzing dimensional data. Part of that program was the installation of PolyWorks® 3D metrology software from InnovMetric Software, a full featured metrology software that automates and streamlines many of the operations associated with gathering and comparing dimensional data with design intent.

The PolyWorks software is used in conjunction with a FARO Laser Line probe mounted on a high precision Faro Platinum Arm. The hardware/software combination cut inspection and analysis time in half and reduced the number of people required for the operation from four to two. In addition, the manufacturing group can now operate independently and work a 24-hour per day shift.

## Collecting Point Cloud Data

In practice, the FARO Laser Line probe collects dimensional data at a rate of up to 19,200 points per second. In the 10 to 15 minutes of the inspection routine for the Weatherford fluid power sections, a point cloud of millions of data points is collected to create a highly detailed dimensional picture of a part feature.

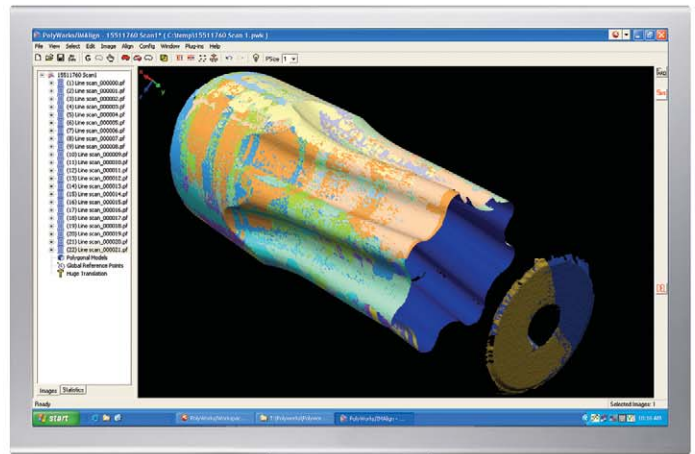
“We let the PolyWorks software do the work—the mathematics—of determining how to take the proper cross section,” Pilgrim said. “Because of its auto alignment capabilities, PolyWorks software assures consistent results, eliminating operator influence during data gathering.”

The company uses an in process inspection approach on a batch basis. “For example, if a batch of five parts is being produced, operators will perform the PolyWorks/FARO Laser Line probe inspection process on the first piece and

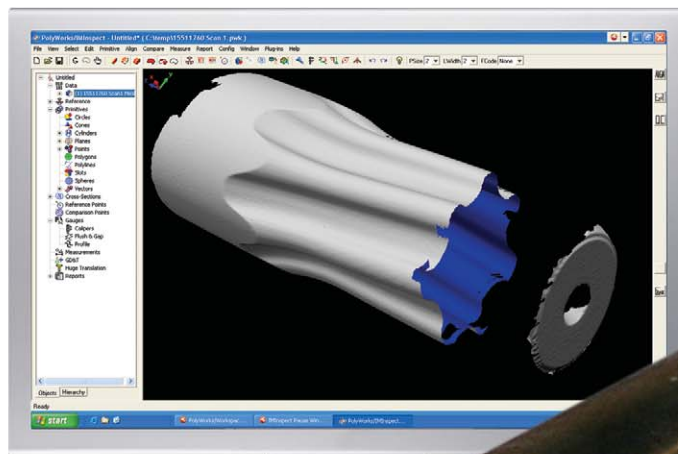
then use the same CNC program to make the next four with no PolyWorks/FARO laser inspection,” said Pilgrim. “We inspect the finished product only if it is considered questionable by other inspection methods.”

The inspection process for the fluid power section components is always the same.

After the first machining cut on a new fluid power section model, a raw data point cloud is collected through the 3D scanning process. From the point cloud, the PolyWorks software creates a mesh that is loaded into the PolyWorks/Inspector™ module. Using PolyWorks’ data-to-CAD alignment techniques, the operator aligns the mesh with the reference object, a ProENGINEER file imported into PolyWorks, to register both models in the same coordinate system. Once perfectly aligned, the operator specifies a cross-section where the data-to-CAD comparisons need to be performed.



**Figure 1:**  
Alignment of multiple scan passes



**Figure 2:**  
PolyWorks mesh model

Scanning using  
the FARO Laser  
Line probe



*Operators  
have found  
the PolyWorks  
software easy to use.  
The automated features  
of the software really  
set it apart.*

**Travis Chometsky**  
Weatherford Product  
Designer and PolyWorks  
software expert at  
the facility

Date: 09/18/2007

CASE STUDY

Table Type		Data to Reference (Data Point)	
Cmp Object(s)	15511760 Scan1 Mesh	Ref	047578202stdmill.prt.1
Cmp Dist	0.010000	Cmp Angle	0.010000
HiTol +	0.003110	LoTol +	0.001535
LoTol -	-0.001535	HiTol -	-0.003110
Err Dir	Shortest Distance	Offset	
		#Points	95276
		Mean	-0.000751
		StdDev	0.001727
		RMS Error	0.001884
		MaxErr +	0.004093
		MaxErr -	-0.006327
		Max Error	0.004093
		Min Error	-0.006327
		Profile of a surface	0.010421
		Pts within +/- (1 * StdDev)	62038 (65.113985%)
		Pts within +/- (2 * StdDev)	91669 (96.214157%)
		Pts within +/- (3 * StdDev)	95259 (99.982157%)
		Pts within +/- (4 * StdDev)	95276 (100.000000%)
		Pts within +/- (5 * StdDev)	95276 (100.000000%)
		Pts within +/- (6 * StdDev)	95276 (100.000000%)
		#Pts Out of HiTol	10579 (11.103531%)
		#Pts Out of LoTol	38341 (40.242034%)
		Surface Out of HiTol	11.573381%
		Surface Out of LoTol	41.021540%



**Weatherford**  
 Model No.: 047578202  
 Reference Model  
 No.: 047578202 STD MILL  
 Serial No.: 15511760 Scan1  
 Processed By: T.Chometsky  
 Date: 09/18/2007

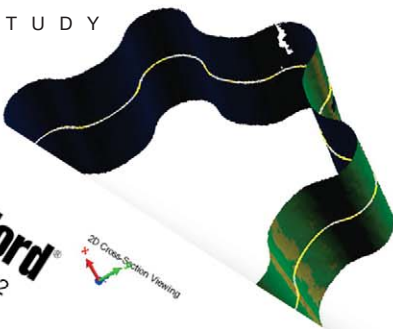
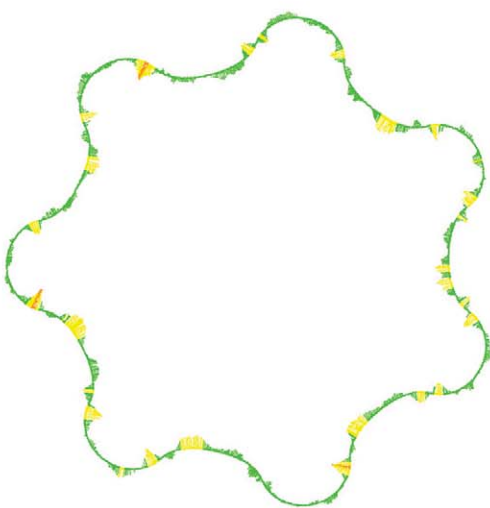


Table Type		Cross-Sections	
Cmp Dist	0.010000	Cmp Angle	
Err Dir	Shortest Distance	Offset	
		Name	
		Cross-Section	



Index	#Points	Mean	StdDev	RMS Error	MaxErr +	MaxErr -	Max Error	Min Error	Profile of a line	%Out HiTol	%Out LoTol
1	1840	-0.000758	0.001728	0.001888	0.003381	-0.005766	0.003381	-0.005768	0.009147	11.467391	40.217391

Table Type

Table Type	Cross-Sections
Cmp Dist	0.010000
Cmp Angle	
HiTol +	
LoTol +	
LoTol -	
HiTol -	
Err Dir	Shortest Distance
Offset	

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Mean	-0.000751
StdDev	0.001727
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#Pts Out of HiTol	10579 (11.103531%)
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Surface Out of HiTol	11.573381%
Surface Out of LoTol	41.021540%

Figure 3: Inspection results

Figure 4: PDF inspection reports



For each cross-section selected, PolyWorks automatically compares the data model to the reference (CAD) model and computes a series of measurements including: standard deviation, max error, min error, etc. (See figure 3). PolyWorks also creates a PDF report of the results of the data-to-CAD comparison (See figure 4). From this report, the machine operator makes adjustments. Another section is machined and scanned again to determine if the adjustments have brought it closer to design intent.

Thanks to powerful macro-programming capabilities, operators do not have to manually perform all of the alignment and comparison tasks in PolyWorks for each new part. In one mouse click, the complete inspection process, from alignment to comparisons and report generation, can be automatically performed for every section that is scanned.

# Results

*You don't need  
a lot of programming experience  
to be able to quickly set up a process.  
The macro programming language is easy to  
use and records actions in a command window.  
We've shown that this approach to inspection can  
save time and money in manufacturing operations  
and we're ready to help other departments  
implement this approach as well.*

**Travis Chometsky**  
**Weatherford Product Designer  
and PolyWorks software expert  
at the facility**





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