in-process testing

axle manufacturing

M10 Gear Quality Verification

Test Description: Verify machining quality through vibration analysis on gear test machine prior to assembly.

Signatures: Vibration vs. time or encoder. FFT and order tracking.

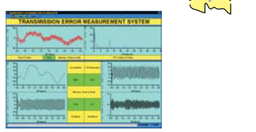
Defects: Gear geometry, machining problems, nicks, burns, alignment, surface finish, sub-micron machining errors, etc.

M20 Gear Transmission Error

Test Description: Measure gear error (commonly known as transmission error) as gear set is rotated.

Signatures: Input vs. output position, filtered and FFT analysis of difference.

Defects: Gear geometry, gear machining problems, nicks, burns, alignment, etc.

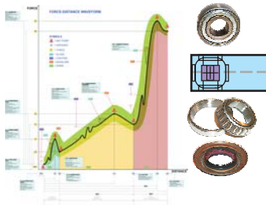


10 Press Monitoring

Test Description: Monitor press load and displacement as parts are pressed together.

Signatures: Force vs. time, distance vs. time, and force vs. distance.

Defects: Loose part, oversized parts, not fully bottomed out part, damaged or bent parts, cracked bore, debris, incorrect bearing, out of round.



50 Ring Gear Run Down

Test Description: Monitor torque vs. angle during run down.

Signatures: Torque vs. Angle.

Defects: Cross threads, damaged bolts.

Traceability: Store entire torque waveform in a database.

70 Axle - Sub Assembly

Test Description: Axle turned by drive motor at different speeds with and without output load.

70a Torque - Sub Assembly Test

Test Description: Measure input shaft torque against angle as motor drives axle in forward and reverse, with and without output load.

Signatures: Breakaway and running torque vs. angle.

Defects: Damaged gears, tight assembly, dirt and debris, incorrect gear contact pattern (visual).

70b Ratio and Backlash Check - Sub Assembly Test

Test Description: Measure input shaft position and output shaft position as motor rotates input shaft.

Signatures: Input and output shaft position (encoder), forward and backward rotation.

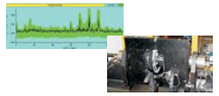
Defects: Incorrect ratio, incorrect gear backlash.

70c Vibration - Sub Assembly Test

Test Description: Measure vibration as motor rotates input shaft. Sensors contact axle casing.

Signatures: Vibration vs. time and vs. angular position (order tracking).

Defects: Gear knock, poor gear finish and geometry, damaged gears, shaft rubs, incorrectly shimmed pinion, damaged bearings.



70d Other Data - Sub Assembly Test

Test Description: Enter various other data, such as; Gear mark (classification of mesh pattern using marking compound), Build dates, Serial number (Bar Code).

Defects: Incorrect gear mark.

70e Gear Mark - Sub Assembly Test

Test Description: Image capture and storage (using vision system).

Traceability: Allows review of mesh patterns for defect containment and recall management.

ZONE DATA COLLECTOR — Q10

Function: Upload all test and operation status results from RF tag /PLC device to QualityWorX™ for a birth history record.

Advanced Features: Allows operation data and status to be available in Repair Bay.

80 Tube Press Monitoring

Test Description: Verify force curve and final press depth as tubes are pressed into casing.

Signatures: Force vs. distance.

Defects: Oversize/undersized, out of round, debris, not to final depth.

20 Tone/Exciter Ring Gaging

Test Description: Using an encoder and laser or inductive sensor, verify ring profile, number of notches, and symmetry and depth of each.

Signatures: Depth vs. angle.

Defects: Improper spacing, bad machining, missing or damaged teeth, wrong number of teeth, eccentricity.

30 Thread Verification

Test Description: Verify the presence and integrity of major fastening points on axle assembly before it goes to the vehicle assembly plant.

Signatures: Eddy current or laser sensor vs. thread depth.

Defects: Missing threads, wrong pitch, shallow holes, undrilled holes, damaged threads.

40 Pinion Nut Torque

Test Description: Measure drag torque as the pinion nut is tightened to set bearing pre-load. Collapsible or solid spacer derivatives.

Signatures: Torque vs. angle.

Defects: Incorrect pre-load, spacer integrity, dirty bearings, thread quality.

60 Balance Station

Test Description: Spin the input shaft to determine weight amount and position to balance assembly.

Signatures: Vibration vs. angle (X-Y, 1 plane). An out of balance assembly yields a sinusoidal acceleration signature where the amplitude is proportional to the amount of weight, and the phase of the peak is used to calculate the correction weight position.

REPAIR BAY MANAGER — Q20

Function: Associate test and operational step failures to defects and repairs.

Advanced Features: Defect Prediction based upon volumetric or statistical data.

90 Liquid Gasket Verification (Partnership Solution)

Test Description: Monitor the dispensing process while beads, swirls or drops of liquid gasket or sealant is applied.

Signatures: Pressure vs. time, flow vs. time.

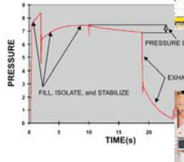
Defects: Air bubbles, blocked nozzles, incorrect nozzle, too little or too much sealant, etc.

100 Leak Test

Test Description: Verify casting and seal integrity using a pressurized air test.

Signatures: Pressure decay vs. time or mass flow.

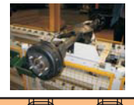
Defects: Missing or leaking or damaged components (plugs, gaskets, RTV, seals), casting porosity.



REPAIR BAY MANAGER — Q30

Function: Associate test and operational step failures to defects and repairs.

Advanced Features: Defect Prediction based upon volumetric or statistical data.

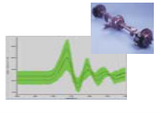


130a Mechanical - End of Line Test

Test Description: Measure input shaft torque against angle as motor drives axle with and without output shaft load.

Signatures: Breakaway and running torque vs. angle, input/output shaft position, gear ratio, backlash.

Defects: Damaged/incorrect gears, tight assembly, rubs, debris.



130c Brake Test - End of Line Test

Test Description: Measure input shaft torque against angle as motor drives axle with and without hydraulic and cable brakes operated. (Hydraulic system verified using compressed air). Leak test of hydraulic circuit. Force/Distance measurement of cable pull.

Signatures: Drive torque vs. angle, cable pull force vs. distance, hydraulic circuit pressure vs. time (leak).

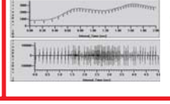
Defects: Missing brake components, snagged/stiff cables, leaky seals/joints.

130d ABS Sensor/Circuitry - End of Line Test

Test Description: Measure ABS sensor output as axle is driven by motor. Also verifies the presence of the tone ring and identifies correct tone rings.

Signatures: ABS pulse value vs. shaft angle, Pulse spacing.

Defects: Damaged/faulty ABS sensors, damaged wiring/connections.



130 End of Line Test

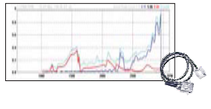
Test Description: Axle is turned by a drive motor at different speeds with and without output load, all functions verified.

130b Sound/Vibration - End of Line Test

Test Description: Measure sound and/or vibration as the axle is driven at various speeds.

Signatures: Sound/vibration vs. time, sound/vibration vs. shaft speed (order tracking), psycho-acoustic parameters (e.g. loudness).

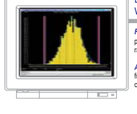
Defects: Damaged/poor quality gears, bearings, splines, resonance's, loose items, axles which will be noisy in-vehicle.



Engineering Workstation Reporter/ Web Reporter Workstation — Q40

Function: Used to review data and generate reports for individual parts as well as to review and generate reports of trend data for a range of parts.

Advanced Features: Create waveform overlays where test data from multiple parts can be compared, generate repair reports that can be used to identify problem areas on the manufacturing line.



120 Hand Brake Force Test

Test Description: Pull hand brake cable to verify resistant force.

Signatures: Force vs. cable displacement.

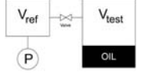
Defects: Binding cables, missing drum springs, damaged rivets, missing brake components.

110 Oil Fluid Level Test

Test Description: Estimate oil level using pressure change and reference volume.

Signatures: Pressure change vs. time, PV/=nRT ideal gas law, Vtest = (P1/P2-1) • Vref

Defects: Too much or too little oil.



sciemetric®
the science of quality

in-process testing
axle manufacturing

Sciemetric delivers test instrumentation and manufacturing intelligence software to detect defects and analyze root causes to provide quality improvement in axle manufacturing.

PROVEN IN-PROCESS TESTING: Sciemetric' has a range of affordable and scaleable solutions with built-in signature analysis software and proven applications to add in-process testing to new and existing axle assembly lines to improve quality and productivity.

FLEXIBILITY: The flexible nature of Sciemetric"s systems allows universal application across assembly lines since the same software and equipment can be used for many applications such as press monitoring, leak testing, torque testing, gaging, cold testing, vibration analysis, thread verification, balancing, welding, and many others.

LEGEND	NAME:	AXLE MANUFACTURING BLUEPRINT	DATE: NOVEMBER 2005	REVISION: 02
= KEY IPT APPLICATION = MACHINING LINE = ASSEMBLY LINE = END OF LINE TESTS = SAMPLE QualityWorX™ STATION(s)	COMPANY:	SCIEMETRIC INSTRUMENTS INC. Toll-free in North America: 1-877-931-9200 Visit our Web site for international contact information email: inquiries@sciemetric.com Web: www.sciemetric.com	sciemetric®	
	NOTE:	Refer to Automotive section of our Web site for more details on Sciemetric' in-process testing solutions. The applicability of each test and the defect detection success depends on many factors including the axle design and manufacturing process. Contact Sciemetric' to obtain more information.		IPT 009

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