Process reporting

Problem

When a manufacturing process is dependent on an external or offline measurement method, finished part dimensional information is the only data normally collected for quality assurance or traceability purposes. Unfortunately, this dimensional information is the sum total of the interactions of many process variables and events during the total machining process.

In the event of a subsequent quality non-conformance, it is difficult to establish exactly the sequence of events and interactions that occurred while machining the defective parts.

When quality issues arise, the logical, structured approach to problem investigation is to introduce additional measurements and recording of process events to characterise the process and understand the variability. This incurs time and effort. It also introduces delays in solving the root cause of the problem and implementing improvements.

Solution

Most CNC control systems have the capability to send customised information through RS232 serial ports, an Ethernet connection, or to the hard disc of the CNC control.

The reporting capability allows a traceable record of the 'route' used to manufacture a component to be stored along with the component inspection data. For example, it is possible to log any detail of machine updates, required re-machining, or tools that were broken.

This 'route' information can subsequently be used to analyse the process and to identify when changes were introduced which may have affected the yield or efficiency.

Process 'route' data can include:
• time and date stamp for an activity
• record of inspection data against a batch or part number
• record of tool offsets established through tool measurement
• record of tool offset correction following feature measurement
• record of any alarms generated by macro code
• record of restart after operator intervention
• reports from logic elements e.g. 'feature required re-machining'
• information from machine based measurements or activities, e.g. critical features

Perform update

Report on update

Track updates over time
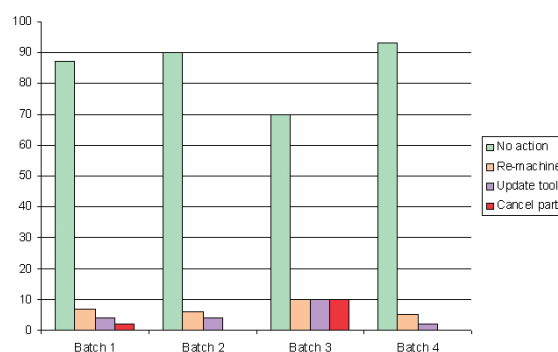
Benefits

- Complete process history log of all measurements and decisions taken during the machining process
- Allows downstream analysis for problem investigation
- Enables monitoring of discrete events, capability measurement and process control
- Activity log to determine utilisation and performance levels

Case study

Output data from an automated machining system:

```
RESTARTING
PRESS CYCLE START TO CONTINUE
376
CYCLE START PRESSED
TIME 10.38    DATE 23 10 09
FIXTURE START---CAR35 POSN12 PROG8945
RESTART ABOUT TO HAPPEN
----------------------
PROG 9033 X-214.6850 Y-254.5510 Z-426.2460   VAR 681 0.2275
PROG 9003 VAR 691 -214.685 VAR 644 SET TO -214.361

TIME 10.40    DATE 23 10 09
G55 FOR T7 COMPT 1X-272.109 Y-366.533 Z-418.146
G55 FOR T7 COMPT 2X-368.103 Y-366.531 Z-418.146
G55 FOR T7 COMPT 3X-464.100 Y-366.535 Z-418.146
G55 FOR T7 COMPT 4X-560.098 Y-366.552 Z-418.146
G55 FOR T7 COMPT 5X-656.094 Y-366.562 Z-418.146

BATCH 406 WING 12 COMPT 1 MEASURED WIDTH 20.648
BATCH 406 WING 12 COMPT 2 MEASURED WIDTH 20.655
BATCH 406 WING 12 COMPT 3 MEASURED WIDTH 20.656
BATCH 406 WING 12 COMPT 4 MEASURED WIDTH 20.661
BATCH 406 WING 12 COMPT 5 MEASURED WIDTH 20.668

TIME 11.13    DATE 23 10 09
T29 LENGTH OLD 228.383   NEW 228.409

LAST ON WING INSPECTION DATA
TOP HSG OP20 PROG 8046
LAST PART ON WING 12
---------------------------
TOOL 8
P65 X20.000 Y5.000 Z NOM 0.000 ACT -0.036 DEV -0.036
P66 X0.000 Y15.000 Z NOM 0.000 ACT -0.022 DEV -0.022
P67 X-20.000 Y5.000 Z NOM 0.000 ACT -0.002 DEV -0.002
MAX -0.002 MIN -0.036 SPRD 0.034 AVE -0.020
OLD OFFSET G55 X-656.094 Y-366.562 Z-418.146
NEW OFFSET G55 X-656.079 Y-366.547 Z-418.146
---------------------------
TOOL 10
P72 X NOM 16.957 ACT 16.952 Y NOM -20.956 ACT -20.964 DEV 0.009
P73 X NOM 20.082 ACT 20.076 Y NOM -15.543 ACT -15.553 DEV -0.011
P74 X NOM 15.813 ACT 15.822 Y NOM -16.687 ACT -16.693 DEV -0.011
P75 X NOM 21.226 ACT 21.228 Y NOM -19.812 ACT -19.814 DEV 0.003
MAX 0.009 MIN -0.011 SPRD 0.020 AVE -0.003
---------------------------
CYCLE TIME TOP HSG 0.747HOURS
```

Output data from a mill-turn machine during batch manufacture:

```
05 November 200916:21
CYCLE START
PART   159T 1836 5 11
---------- --------- ---------- --------- ---------- ---------
              PART   160       5 11 2009    18.36
---------- --------- ---------- --------- ---------- ---------
FEATURE 13 0FFSET 50
OPPOSED SPINDLE INTERNAL FINISH TURN
X   -  .007  Y   -  .011  Z       5.002  SIZE   47.976
OLD WEAR OFFSET X    .032  Y    .000  Z    .102  R    .000
NEW WEAR OFFSET X    .057  Y    .000  Z    .102  R    .000
CONTROL LIMIT EXCEEDED INSPECTING NEXT PART
FEATURE CORRECT
---------- --------- ---------- --------- ---------- ---------
PART   160 SUSPECT INSPECTING NEXT PART
---------- --------- ---------- --------- ---------- ---------
CYCLE TIME   .292 HRS
PART   160T 1854 5 11
---------- --------- ---------- --------- ---------- ---------
              PART   161       5 11 2009    18.54
---------- --------- ---------- --------- ---------- ---------
FEATURE 13 0FFSET 50
OPPOSED SPINDLE INTERNAL FINISH TURN
X   -  .011  Y   -  .010  Z       4.999  SIZE   48.026
OLD WEAR OFFSET X    .057  Y    .000  Z    .102  R    .000
NEW WEAR OFFSET X    .031  Y    .000  Z    .102  R    .000
CONTROL LIMIT EXCEEDED INSPECTING NEXT PART
FEATURE CORRECT
---------- --------- ---------- --------- ---------- ---------
PART   161 SUSPECT INSPECTING NEXT PART
---------- --------- ---------- --------- ---------- ---------
              PART   162       5 11 2009    19.08
---------- --------- ---------- --------- ---------- ---------
FEATURE 13 0FFSET 50
OPPOSED SPINDLE INTERNAL FINISH TURN
X   -  .010  Y   -  .008  Z       5.000  SIZE   48.002
OLD WEAR OFFSET X    .031  Y    .000  Z    .102  R    .000
NEW WEAR OFFSET X    .031  Y    .000  Z    .102  R    .000
FEATURE CORRECT
---------- --------- ---------- --------- ---------- ---------
PART   162 OK
---------- --------- ---------- --------- ---------- ---------
PART   171T 2124 5 11
FEATURE 13 LIFE EXPIRED
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
100.3 PCENT - F 13 -
```

Example: inspect a major feature, perform tool length update and report on outcome of both

Sample Productivity+™ probe software program

⊟ 📄 Inspection Cycle: Main_feature 　└ 🔵 Measured Circle: Circle1 　　● Measured Point: Point1 　⋯ 🔧 Machine Update: Update_Tool_Length	Inspect main machined feature and perform tool length update.
⊟ 📄 Inspection Cycle: Cycle2 　⊟ 📝 Report: Report1 　　↱ Reference to: Circle1 　　↱ Reference to: Update_Tool_Length	Report on main circle feature (including tolerance check) and tool length update.

Sample Inspection Plus software program

N10 G0 X0 Y0 Z10.	Positioning move to measuring clearance point
N20 G65 P9810 Z-5. F3000	Protected positioning move into bore for measuring
N30 G65 P9814 D20.0 W2.0	Measure 20 mm bore, increment component number, reset feature number
N50 G0 Z10.	Move to clearance position
N60 G65 P9810 X 15.	Protected positioning move to measuring point
N70 G65 P9811 Z0 T20. W1.0	Measure Z0 face, increment feature number, update tool length offset 20
N80 G0 Z10.	Move to clearance position
N90 G65 P9810 X0 Y10.	Protected positioning move to measuring point
N100 G65 P9812 D50. Z-10 W1.0	Measure 50 mm wide web, increment feature number
N100	Continue

Output data from sample Inspection Plus software program

```
----------------------------------------------------------------
   COMPONENT NO 4                      FEATURE NO 1
----------------------------------------------------------------
SIZE D20.0000     ACTUAL 20.0240     DEV .0240
POSN X.0000       ACTUAL -.0740      DEV -.0740
POSN Y.0000       ACTUAL -.0220      DEV -.0220


----------------------------------------------------------------
   COMPONENT NO 4                      FEATURE NO 2
----------------------------------------------------------------
TOOL OFFSET H32
SIZE Z.0000       ACTUAL .0175       DEV .0175


----------------------------------------------------------------
   COMPONENT NO 4                      FEATURE NO 3
----------------------------------------------------------------
SIZE D60.0000     ACTUAL 60.0160     DEV .0160
POSN X.0000       ACTUAL -.0400      DEV -.0400
POSN Y.0000       ACTUAL .0000       DEV .0000
```

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