# Quality Measures Support Cycle Time Concept and Insure Business Process Consistency

*Process and product gains at Alvey Systems, Inc.*

Paul N. Brauss

Using standard quality system measures just doesn't fit a company's culture after adopting cycle time as an operating philosophy. The quest is to identify quality measures which check *process*, as well as product quality. Alvey Systems, Inc., a manufacturer in the material handling equipment industry, found this to be a major step in their cycle time reduction initiative. It is great to reduce cycle time, but if it means skipping steps or taking shortcuts, all professed gains are lost. Cycle time measures must be teamed with process quality measures to ensure things are done correctly the first time.

This leg of the continuous improvement journey emphasizes competing process steps with little or no rework. Meanwhile, product quality is married with process quality. This is how Alvey Systems made the leap.[1, 2]

### Process Quality

In 1997, Alvey management picked several process steps (such as expediting and late deliveries) to implement quality measurements in order management, design engineering, and manufacturing. The steps identified were known to have problems. In turn, these problems affected the normal work flow. Management thought that if we could fix the problems such as engineering change implementation, rework caused by customer changes, repetitive design enhancement errors, and sales compensation errors in these process steps, we would amplify the significant results already achieved with cycle time.

Using standard problem-solving techniques, team facilitators went to work in each area, brainstorming problems such as order management that prevented the process from being completed correctly 100 percent of the time.

*First, we focused on order management.*

First, we focused on order management. What was the hold-up? Why were we reentering orders? Why did it take days to process orders and why were there so many orders requiring data modifications?

What we found was that most of the data sheets required by order entry were being revised days or weeks after an order had been entered. The hold-up was not in order management, but rather in the hand-off from sales to order management. The first measurement had been identified.

Our measurement became the quality/completeness of the initial order management documentation. This issue had a greater impact than we knew because in the design process, one of the major barriers causing design changes was order entry documentation changes; also, one of fabrication's issues was the numerous changes in design. The process chain was feeling the impact of the first link's problems.

A simple measurement chart (Figure 1) was created for data completeness and quality. Measurement focused on all of the documents being complete, or yield of the process. With upper management there to support this measurement, the sales manager's performance compensation was factored by yield improvements in this process.

Within three months of implementation, the yield improved from 30 percent baseline to nearly 100 percent every time. The process benefits were seen in many steps, just by taking the kinks out of the first link.

### Design Step Changes

Similar to the approach in order management, the design step also required study. We knew one cause of design changes (completeness of technical data/quality of technical data), but could not put a finger on the magnitude of the problem. In the design step, we decided to gauge revisions to a design release. Because Alvey is a design-to-order business, we accepted a certain amount of revisions to a design.

Once we tied a measurement to this step, we soon discovered a different story. The measurement for the design yield was basically engineering releases divided by engineering releases with revisions. Baseline data showed a 50 percent yield. By collecting the data, resolving the problems (such as inappropriate assumptions about design requirements and specific requirements of design data) with basic problem-solving techniques such as fishbone diagrams, and then tying a portion of sales and design middle management's compensation to related performance improvement, we rapidly improved the yield of this process. (See Figure 2.)

### Procurement Focus

In procurement, the example was followed again. The focus was on timeliness of component delivery. The previous measure of vendor on-time performance seemed to mask process needs. Components were needed in conjunction with the assembly start date. The old measurement of vendor on-time considered performance to leadtimes and a negotiated date. This metric did not always agree with assembly needs, and thus there was a difference in perceived performance.

The measurement was modified to focus on the process need. On-time now meant on-time to production planning commitments. Once again the measurement was tied to management's compensation. Results were dramatic and the baseline of 65 percent was raised nearly 95 percent within nine months (see Figure 2).

### Results Over Time

Process quality measures were defined by a fixed cross-functional team. Measures are reviewed at each weekly meeting of the team (see Figure 2).

This focus on revised metrics and a link between results and managers' compensation united us in the achievement of common goals. The identification of process steps to be measured, brainstorming and other

*... the design step also required study.*

**Alvey Order Entry Checklist**

Date:

Score ________ %
________ of ________

TO: ________
FROM: ________
Received 500 form: ________
Customer: ________
Location: ________
Order type: DISTRIBUTOR - HARDWARE

Copy:
Order No: ________
Prop No: ________
Addendum $ ________
*Order Total* $ ________

***Additional information needed on 500 Form prior to OMAR entry:*** ☐ None ☐

| **Required** | **Responsibility of:** | | **Received:** |
|---|---|---|---|
| ☑ PO Number<br>*Restricted entry authorized by:* ________ | Sales Representative | ☐ | ________ |
| ☑ Ship to/Bill to Address | Sales Representative | ☐ | ________ |
| ☑ Sales Agent Number | Sales Representative | ☐ | ________ |
| ☐ Name, address and phone number of Finder's Fee payee (Finder's Fee Only) | Sales Representative | ☐ | ________ |

***Other documents needed prior to OMAR entry:*** ☐ None ☐

| | | | |
|---|---|---|---|
| ☐ Approval for Finder's Fee (Finder's Fee Only) | Sales Representative | ☐ | ________ |
| ☑ Manual Estimate | Sales Representative | ☐ | ________ |

**Order Entered:** ________

***Other documents or information needed to complete the order processing:***

| | | | |
|---|---|---|---|
| ☐ Pallet Conveyor Packet (Act 212) | Operations Mgr. | ☐ | ________ |
| ☐ PSR - Conveyor | Request sent to: ________ | ☐ | ________ |
| ☐ PSR - Controls | Request sent to: ________ | ☐ | ________ |

**Figure 1.** *This simple measurement chart was created for data completeness and quality.*

## Alvey Make Process First Pass Yield

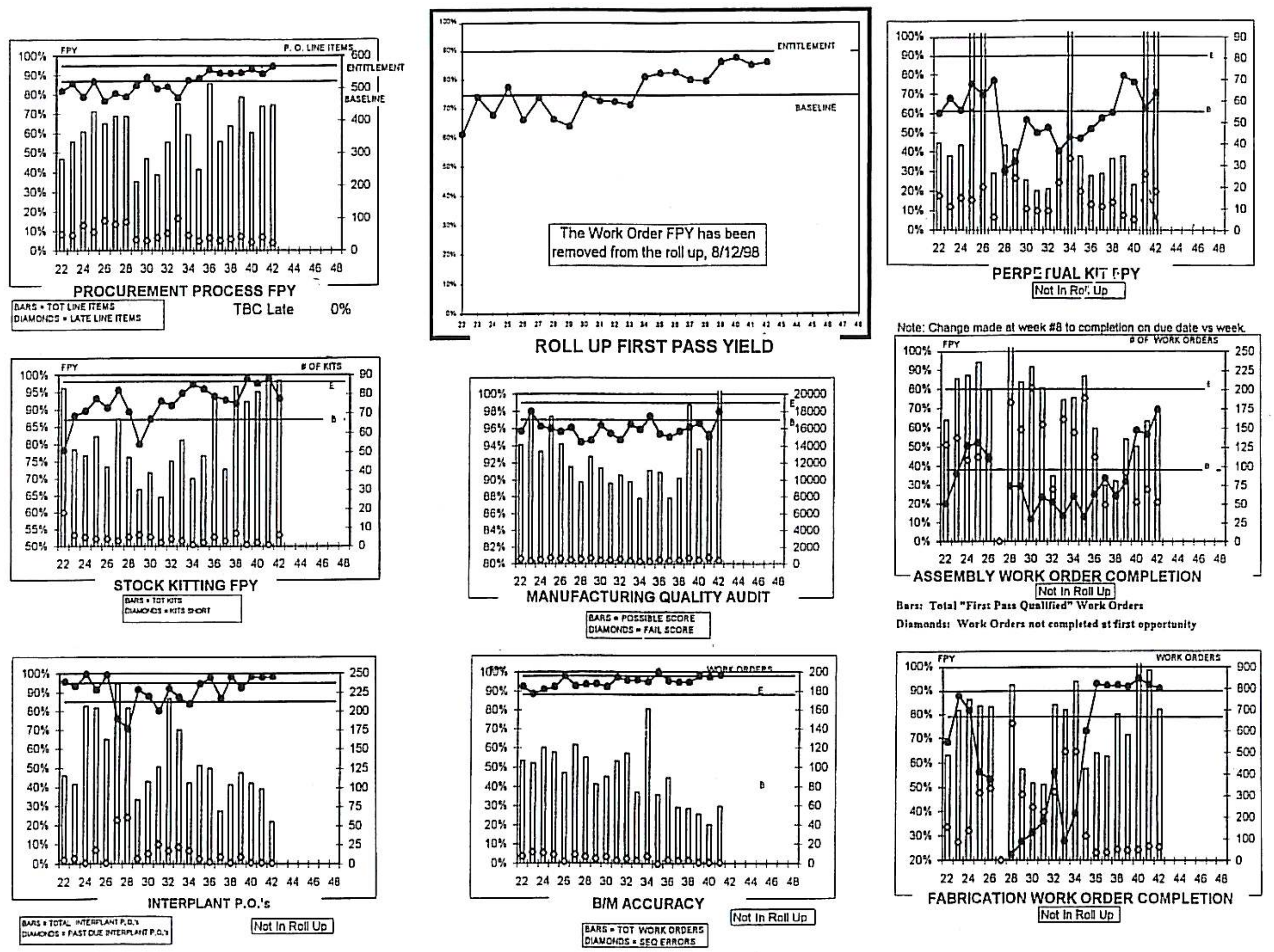



***Figure 2.*** *Process quality measures, defined by a cross-functional team, are reviewed at each weekly meeting of the team. These charts were developed with the help of the Thomas Group.*

problem-solving techniques, and step-by-step resolution of performance issues (see the palletizer process chain chart — Figure 3) really worked. It took about six months to determine the best measurements and then another six months to achieve the significant results we had planned. We documented savings as we used problem-solving worksheets.

### Product Quality

We devised enhanced product quality measures as well. We recognized that we had to reexamine product quality audits, for example.

To begin, the product quality assurance team conducted a self-appraisal of exactly what the goals of the audits were. Rather than search for a number that would fall within the level of the control limits, the organization determined that their goal was to raise the awareness of quality and develop a method for communicating expectations to fabrication, subassembly, final assembly, and stockroom employees.

With this new thrust, the next step was to develop a clear set of instructions for measuring the variables in each component. These instructions were written in simple formats for each process in the facility (an example is shown in Figure 4).

Over 150 individual product variables were detailed in work instructions designed to meet the company's overall document system. The documented instructions did not introduce one new process to the organization. They did produce one consistent methodology which became the future training documents for the shop floor. The first question of implementation (how?) was resolved. Everyone now knew how the measurements would be taken.

## Palletizer Process Chain

| | Link 1 | Link 2 | Link 3 | Link 4 | Link 5 | Link 6 |
|---|---|---|---|---|---|---|
| | Pre-Order to Post Order → | Post Order to Make → | Make to Post Order → | Post Order to Make → | Make to Post Order → | Post Order to Pre-Order |
| **Description** | Sales receives the order and prepares information for engineering to begin | Engineering completes design and hands off information to mfg. | Product is manufactured per engineering specifications and is ready for test | Machine tests, discrepancies are found, direction is given for modification. Teardown approval given | The machine is shipped and received in the field | The machine is up and running and the customer accepts |
| **Output** | Technical documents | Drawings<br>Test requirements<br>Special instructions<br>Shipping bill of material | Machine is ready for engineering test<br>Platforms are in place | Punch list, if required<br>Approval to proceed | Shipping documents<br>Proof of receipt<br>Shortage list | Customer sign-off and accepts machine |
| **Activity** | Sales turnover meeting | Palletizer start-up meeting<br>1. Meeting attendance poor — reimplemented in late August | 1. A "test ready" check sheet has been developed - 10/10<br>2. A "demo-ready" check sheet has been developed - 10/10<br>3. Red Book* shows verification | 1. Creation of discrepancy list<br>2. Red Book is authorized<br>3. Cost and status of machine is rolled<br>4. Join quality audit five machines for completeness | 1. Customer service engineer starts up machine and writes report<br>2. Quality assurance receives report and summarizes issues; forwards to engineering/mfg.<br>3. BRTs** to begin 10/13 | Close out warranty segment |
| **Measurement** | Sales turnover first pass yield (FPY) | FPY at induction | "Test Ready"FPY? | Demo complete | Field report | Close out form warranty cost. |

* Red Book = test documents that will become a record of results ** Barrier Removal Team

***Figure 3.*** *Identifying process steps to be measured, brainstorming and other problem-solving techniques, and resolving performance issues step-by-step really worked.*

### *The Next Step*

The second leg of implementation was the most difficult. The audit process had to be completed by someone. Hiring people just to take measurements did not set well with management; in retrospect, it did not support the concept of increasing quality awareness with the shop floor.

Managers, supervisors, and the union stewards were brought together, and the importance of each group in this quality measurement focus was explained. Each group was told that they had to accept responsibility for quality, and that we would man the audits with shop people from their ranks. This was accepted like a match at the Hindenburg. Nonetheless, the auditing began. The first few weeks of implementation were miserable. Volunteers were scarce and the program seemed destined for failure.

### *Back to the Drawing Board*

After two months, it was back to the drawing board. This time, the auditing process was redeveloped. Using the same instructions for measuring variables, a sole inspector was tasked with spending all of his/her time conducting audits. The audits were to be conducted in the operator work cell (as opposed to a special area) with the operator present. The operator could be busy working

## Audit Attribute: Hole Location

| | | |
|---|---|---|
| OWNER: | Tim Knapp | REVISION: B |
| APPROVED BY: | Chris Hutson | DATE: 10/25/96 |
| AUTHORIZED BY: | Ron Hunt | PAGE: 1 of 1 |

**1.0 PURPOSE**

Holes must be within 1/32" of the X,Y location shown on the drawing.

**2.0 PROCEDURE**

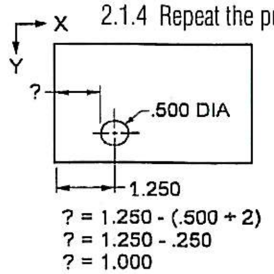
**2.1** Method:

2.1.1 Look at the drawing to determine the X dimension from the edge of the part to the center of the hole.

2.1.2 Subtract half the hole size to get the dimension from the edge of the part to the outside of the hole. (Refer to QWI 309-99 to verify hole size.)

2.1.3 Use a tape measure or calipers to verify that the location of the hole agrees with the X dimension on the drawing.

2.1.4 Repeat the process for the Y dimension.



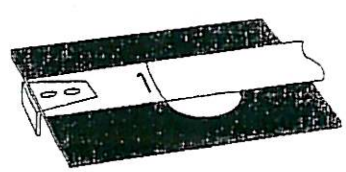



***Figure 4.*** *A clear set of instructions for measuring the variables in each component was developed; they were written in simple formats for each process in the facility, such as this example.*

## Barrier Removal Team (BRT) and Problem Solving Log

| TITLE/DESCRIPTION | OWN | DATE | STATUS | COMMENTS |
|---|---|---|---|---|
| SubAssy. Torque Tests | BS | 1/7 | Complete | Not torqued per QWI* 309-151 — see new BRT for cracking set screws (#10) |
| Shaft Keys | BS | 4/8 | 20% | Keys too short for keyway, revise QW1 309-167 based on engineering input (See BRT #6) |
| Bearing Installation | BS | 4/26 | 40% | Revise QW1 309-16 & 15 based on engineering input and manufacturer's recommendations |
| Air/Hydraulic Openings Capped | SP | 5/14 | 80% | Working with individual assemblers to improve performance |
| Top-Off Welding | SP | 5/27 | Complete | Initiated an audit of the top-off weld within two days of weld |
| J-Bolts | BS | 6/3 | 50% | Bolts don't stick out of nut, working with vendor to make per drawing. QIK**#053937 & 053708 |
| Weld Quality | BS | 6/3 | 40% | New gas mixture (75/25 Argon), additional training for welders, review QW1 309-13 |
| Cracking Set Screws | BS | 6/3 | Complete | All were failures on taper lock bushings, replaced worn hex bits in subassembly |
| Roller Bearing Caps | SP | 6/8 | Complete | Worked with painting to replace bearing caps prior to painting |
| Layer Guide Handle Bolts | SP | 6/11 | Complete | Worked with purchasing to correct bolt length on transition cap assemblies |
| Safety Sign Installation | SP | 6/24 | Complete | Worked with painting and subassembly to install correct signs in proper location |
| Shaft Keys | SP | 6/30 | Complete | Worked with engineering to correct key lengths on various drawings (affects key retention) |
| Paint Bleed Through | BS | 7/2 | 90% | Worked with painting to improve surface preparation of tubular frames |
| Speed Checks in Red Books | BS | 7/3 | 90% | Worked with electricians to increase awareness of QW1 310-03, revised Red Books |
| Miscellaneous-Final | BS | 7/9 | 80% | Working with subassembly to correct problems before they get to final |
| Control of Safety Labels | RH | 7/21 | 20% | Use and location of conveyor safety labels in uncontrolled |
| Tie Sheet Dispenser | BS | 8/4 | 50% | Aluminum frames cracking along bend, design & manufacturing engineers revising MDP 5.01*** |
| 910 Audit Data | SP | 8/11 | 40% | Reviewing drawings and auditing finished parts and assemblies |
| TIR****on Tubing & Rollers | BS | 8/14 | 40% | Reviewing engineering requirements, or lack of (See BRT#15) |
| Laser Parts | SP | 8/14 | 80% | Working with fabrication to get laser parts corrected to match drawings |
| Sprockets on Rollers | SP | 8/20 | 50% | Working with fabrication to improve weld quality and sprocket location |
| Infeed Ratchet Handles Mixed | SP | 9/18 | 50% | Stockroom has mixed handles, ratchets, and knobs in bins, refer to QIK#053709 & 053710 |

* Quality work instruction  ** Quality/key — deviation report  *** Mechanical design practices  **** Total indicated run out

***Figure 5.*** *Weld quality and other issues were tackled using a barrier removal team (BRT) log.*

on the next assembly of components, but they were close by. As auditors completed reviews, they were often found going over the audit techniques with the operators.

To help simplify communication, the audit attributes and the instructions on measuring were located on the production floor with access to everyone who wanted to read or use them. This change addressed one of the fundamentals requested of all operators: to communicate expectations.

With this sharing of information, fabricators and assemblers were becoming more enthusiastic. The quality auditor began detailed training classes for any volunteers. Training was specific to their operations (for example, welding, blueprint reading, assembly practices, motor assembly, and set screw torquing) but also personal enough to arouse curiosity about other areas. Fabricators were becoming more interested in how their quality affected the end product. Subassembly learned about their impact on the final assembled product.

Within six weeks, the auditors were conducting full audits and the original quality assurance auditor began auditing the volunteers. This provided a needed feedback loop for improvement.

The amount of data being gathered still did not measure up to a statistically sound sampling level. Variable-level data did point to certain fundamental issues. These issues were tackled using a barrier removal team (BRT) log (Figure 5).

### Resolving Problems Using Data

Using the data to resolve problems became the third leg of this process. Brainstorming sessions were held on improving product quality, based on available data. Issues were then identified and prioritized according to their difficulty of resolution and dollar impact. Easily-resolved items were given higher priority.

Cross-functional problem-solving teams (management selected teams by their process area) were assigned specific problems and given latitude to solve them. The results were communicated weekly at the operational staff meeting where the team leader could present progress or identify roadblocks requiring staff intervention. A sample list of top audit problems is shown in Figure 6. The teams were given support to resolve the issue, typically achieved as a 50 percent improvement — and as much as a 100 percent improvement — within six weeks.

### *Field Data Connection*

No matter how much internal auditing is conducted within an operation which is manually intensive and non-repetitive, there will exist error. The fourth leg of the product quality audit process is to tie in field data. There was a disconnect which separated field reporting for the field service engineer related to equipment start-up issues in the field. Field service engineers would go to the job site and begin installing equipment. They wrote up lengthy reports explaining reasons for spending too many hours in the start-up without specific causes or issues identified. The reports were sent to the service manager, where they did not receive needed action and distribution.

The fourth leg included writing equipment commissioning instructions which support the attribute instructions and then having the service engineer install equipment and check it out based on this checklist.

The check sheet was then distributed to quality assurance and design engineering, where it was transcribed. These data emulated the data from the internal auditing process. Related issues were made part of the prioritization process; for example, field report problems were made part of the total population of problems. Many times what the field had to deal with was caused by something which should have been part of assembly. The feedback loop could now be closed.

The frustration of repetitive problems and a lack of feedback to this group led to an average 25 percent annual turnover of those employed in the field service organization.

The key ingredient was to change the way many of the field discovered and communicated problems so that the real issues could be fixed upstream. The obstacle was a lack of communication back to their source. The data sheets became the communications tool. With this feedback loop established, we were able to improve our training on product tolerances, installation, and setup to support field service engineers.

### *The Quality Organization's Role*

Typical approaches to quality control by measuring defects and posting numbers had no impact on improving results. The numbers were credible, but what to do with them was unclear. We also discovered that other quality measurements focused on processes were needed in place of existing measurements. A forum had to be created to effectively use the measurements. By linking cycle time and quality measures, Alvey Systems has identified a method that not only improves bottom line results but also protects the customer.

A process chain identifying the internal hand-offs was created to help visualize and clarify the critical steps. The description of these steps plus expected performance was well defined. Finally, our emphasis on quality measurements and cycle time reduction keep the organization focused. Our plans are to reset targets of improvement each year so that our continuous improvement process is maintained. This combination will ensure our continued success in the future.

**Top Product Audit Problems**

| | Hits | Weight |
|---|---|---|
| **Sub Assembly — weeks 13-26** | | |
| Air/hydraulic openings capped | 12 | 52.6 |
| Shaft keys | 12 | 25.4 |
| Cylinder rod ends tight | 4 | 20.4 |
| Miscellaneous | 11 | 19.45 |
| Bearings/taper lock bushings torqued | 8 | 13.6 |
| Weld quality | 11 | 11.3 |
| **Final Assembly — weeks 13-26** | | |
| Bearings/taper lock bushings torqued | 6 | 22.9 |
| Miscellaneous | 11 | 15.75 |
| Signs installed | 4 | 8.75 |
| Cylinder rod ends tight | 2 | 8.3 |
| Verify components (welding) | 5 | 6.45 |
| Air/hydraulic openings capped | 2 | 6.25 |
| Weld quality/adequate weld | 4 | 5.1 |
| **Fabrication — weeks 19-36** | | |
| Sprocket and hub location | 11 | 85 |
| Weld quality | 8 | 56 |
| Edge quality | 14 | 55.2 |

***Figure 6.*** *Cross-functional problem-solving teams were assigned specific challenges; above is a sample list of top audit problems.*

*Our plans are to reset targets of improvement each year so that our continuous improvement process is maintained.*

1. The company's cycle time focus through teamwork was described in the article, "Leadership at Alvey Systems, Inc.: New Measures Drive the Business," by Paul N. Brauss, in the Third Quarter 1998 issue of *Target*.
2. The Thomas Group, a consulting firm based in Dallas, TX, assisted with the implementation.

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