MAST 1 Purchased Products--Components

Kansas City Division

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Abstract

AlliedSignal Inc., Kansas City Division, the production agency, was provided with funding to acquire purchased product components in support of the MAST (Multi-Application Surety Technology) Program. Implementation efforts, closing procurement status, and proposals for improvements in the procurement process are presented.

Summary

The intent of this project was to fund the Purchased Product Team's traditional procurement of components, with significantly reduced flowtime, in accordance with the Qualification Evaluation System, and to exercise the system to the extent possible. When funding was reduced, it became obvious that full implementation of the Qualification Evaluation System could not be achieved due to limited resources.

Discussion

Scope and Purpose

Since MAST 1 (Multi-Application Surety Technology) Program is a demonstration rather than a stockpile program, a funding vehicle was needed for procurement of parts. As a result, this project was designed for that express purpose. All activity of the Purchased Product Team (PPT), which included buyers, quality engineers, and component engineers, was funded under this project.

The scope of the project envisioned at the outset had to be significantly changed because of reductions in funding. This primarily manifested itself in limited availability of technical resources.

Activity

Traditional Component Procurement in Accordance With the Qualification Evaluation System

With project funding approved, procurement activity was initiated under the guidelines of the Qualification Evaluation System. The traditional Purchased Product Team (PPT) approach was utilized for procurement activities. Responsibilities were divided among purchasing, quality, and engineering as follows.

Purchasing

- Supplier selection/management
- Product definition maintenance
- Supplier quote/purchase order
- TMS, EE, QS scheduling at supplier facility
- Definition change response
- Open requirement schedules/expediting
- Formal supplier communications
- Material status/timely feedback
- Coordinate supplier feedback, audits, corrective actions
- Coordinate supplier resolution of defective product
- Price considerations
- Product budgeting control

Purchased Material Quality Engineering

- DOE Quality Assurance interface
- Purchase order quality requirements
- Supplier training - inspection technique
- Supplier quality system adequacy and compliance
- Supplier/product history
- Acceptance equipment, acquisition, validation, and control
- Defect prevention techniques
- Inspection instruction
- Consolidated Approved Supplier List (CASL)

Purchased Product Engineering

- Product definition
- Product requirements
- TMS, EE, QS plan/reviews
- Manufacturability/producibility assessments

- Supplier/KCP (Kansas City Plant) product drawing review
- Process characterization and control
- Process assessment and process audits
- Product disposition
- Development plan schedule - rework instructions
- Capital equipment procurement
- Material deviations
- Product/program reviews
- Product acquisition budgeting (tooling)
- EQ plan/review

Procurement activity was authorized to support MAST schedules. Support components included diodes, switches, integrated circuits, MOSFETs, resistors, capacitors, pulse transformers, connectors, and relays. Periodic procurement review meetings were held to review component logistics, including procurement and flowtime issues at suppliers, interfaces with the design agencies, radiation certification, incoming inspection, packaging, static sensitivity requirements for next assembly, ES&H issues, and the future viability of suppliers. The final MAST component review meeting was held with closing component status reported as follows.

Diodes

Microsemi Corporation (MSC) was the supplier of the SA3441 and SA3670. QERs were received on both devices after successful acceptance and qualification. Quantities to support scheduled program needs were sent to production stores. A quantity of 150 SA3799s was ordered from Semicoa Semiconductor. This device was a first for Semicoa as a supplier of these components. A QER was received for the SA3799 following successful acceptance and qualification.

Further procurement and evaluations were funded under the Preferred Supplier program due to reductions in MAST funding.

Switch Assembly

The current definition was released into the system at both the component and assembly levels. Seven switch assemblies were in stores. Approximately 6200 switch components were in stores and available for procurement at the switch assembly level.

The switches were bought from the supplier, Hermetic Switch. This supplier was listed on CASL (Consolidated Approved Supplier List) and was capable of supplying switch components to the current definition.

An acceptable QER was released in 1987 at the assembly level. Revisions to the QER were suggested based on length of production inactivity and changes to the current product specification.

Travelers and testers were available in Receiving Inspection for component level testing. Assembly fixtures, in-process 100% acceptance testers, and production/inspection travelers were available at the assembly level. Testers and fixtures were available for environmental testing.

Caution notes were in place at both receiving inspection and assembly. The parts were individually packaged in a plastic tube with corks inserted at both ends. The switch assembly does not use or contain any of the materials prohibited by ES&H for MAST applications.

MOSFETs

SA3357-3

The SA3357-3 is a carryover quad N-channel MOSFET originally developed for earlier applications. Supertex is the supplier of this device. A quantity of 1652 of these devices was available in stores. Due to continuing concerns regarding radiation hardness of Supertex devices, the design agency initiated development of the replacement Harris SA3790-1. MAST next assemblies were encouraged to use the SA3357-3s which were available in stores to complete development builds. A decision was made not to re-quality Supertex for further production of the SA3357-3 due to the significant number of parts in stores and plans to procure radiation-hardened replacement devices from Harris Semiconductor.

SA3364

The SA3364 is a carryover quad MOSFET with two N-channel and two P-channel devices in a package. It was originally developed for an earlier application. As there were no unallocated devices available in stores, a decision was made to purchase the Supertex H00094-7, a commercial version of the SA3364, for development use. One hundred sixty-five devices were procured from Supertex. This device was in a similar category to the SA3357-3 in that radiation concerns remained, and a decision was made to replace this device with the SA3904 procured from Harris Semiconductor.

SA3790 and SA3904

These devices are Harris replacements for the Supertex SA3357-3 and SA3364, respectively. The design agency initiated RFI (Request For Information) proposals for quotation of price and delivery by Harris Semiconductor. The primary driver for these devices was that they could be purchased radiation-assured with improved variety in packaging.

PFET

This device was designed to be available in both plain die and packaged form. Micrel Semiconductor fabricated the die based on design agency requirements. Three wafers were processed of JANS-level, which includes full wafer traceability. The packaged version of the device was designed for use on MAST.

Several problems at Micrel had to be overcome: 1) Although Micrel had been previously certified to the KCD requirements, this certification had expired; 2) Micrel had no facility to package die in the required TO-18 package and would require use of an outside packaging service, Pantronix; 3) Pantronix had no capability to perform shock and vibration testing required for Group B mechanical verification.

Plans were made to approve both Micrel and Pantronix with KCP performing shock and vibration testing at Micrel's jeopardy. The possibility of performing source acceptance was discussed. The design agency was interested in performing qualifying testing on these devices.

SA3711 and SA3712

The Harris SA3711 and SA3712 are replacements for the International Rectifier SA3482 and SA3483, respectively. KCP was working towards eliminating International Rectifier as a supplier, thus making Harris Semiconductor the sole supplier of MOSFETs. Harris had a larger variety of radiation-hardened power MOSFET die with

many packaging options. It was, therefore, concluded that all MAST MOSFET needs could be supplied with radiation-hardened devices from Harris.

These devices could be procured in two package versions, LCC and TO-205AF (TO-39). KCP was having problems negotiating PIND (Particle Impact Noise Detection) acceptance criteria with Harris. In addition, Harris' supplier of the TO-205AF package was petitioning DESC (Defense Electronics Supply Center) to remove this package from qualification due to inherent PIND problems associated with this package design.

KCP was successful in persuading MAST to use an alternate to the TO-39. Eventually, MAST was convinced that the TO-39 package was too risky to use in its assemblies. MAST accepted the TO-257AA package in its design, but space and fit concerns were caused by the extended flange mounting tab. Inquiries were made to Harris regarding procurement of a tabless version of the TO-257AA. This improvement would have resolved any space and fit concerns in subsequent builds.

The SA3711 and SA3712 were to be procured, accepted, and qualified according to traditional procurement procedures. MAST required that the QER be subject to the provisions of Qualification of Processes and Products Under Demonstration Programs.

Integrated Circuits

SA2553-1

The SA2553-1 is a carryover quad comparator, the LM139, manufactured by Texas Instruments. There was not a "sunset technology" concern as the device could have been purchased from National, Intel, and Motorola.

The device existed in two versions in production stores--PIND tested (-02) and non-PIND tested (-01). A total of 797 devices existed is stores as the -02; 858 devices existed in stores as the -01 and required PIND, hermetic seal, and electrical tests to be upgraded to the -02; 796 devices in hold stores required PIND and completion of acceptance tests for upgrade to the -02.

The PIND problem was resolved by Texas Instruments taking corrective action to eliminate particulate contamination. Enough devices were procured or screened at KCP to meet life-of-type needs for MAST and other programs.

SA3051

The SA3051 is a carryover LM117 voltage regulator manufactured by National Semiconductor. There was not a "sunset technology" concern as the device could be purchased from other suppliers.

The device existed in two versions in production stores--PIND tested (-02) and non-PIND tested (-01). A total of 336 devices existed is stores as the -02; 236 devices existed in stores and required PIND, hermetic seal, and electrical tests to be upgraded to -02s; 2494 devices in hold stores required PIND and completion of acceptance tests for upgrade to the -02.

Programmable Op Amp

This device was previously manufactured by Harris Semiconductor. The supplier has discontinued production of this device.

A total of 2849 devices was available in hold stores with a varying amount of acceptance

tests completed. All acceptance test equipment was available. Yield after all acceptance testing was estimated at 1100-1600 devices.

Thin Film Resistors

These specifications have been released for 10 to 15 years and procurement had been accomplished through Dale Electronics. These devices are carryovers from previous programs. The producibility rating of thin film resistors is "A" except for the following:

Device	Value Range
Resistor	Over 70K ohm
Resistor	Over 2.05M ohm
Resistor	Over 70K ohm
Resistor	Over 499K ohm

These devices received a lower producibility rating because during DESC qualification unacceptable changes in the larger resistance values had occurred following operating life tests.

The ES&H concern was that these devices contained trace amounts of chromium (less than 0.1%). Trace chromium was determined to be critical in this thin film manufacturing process.

Special Resistors

These special resistors have platinum leads with additional lead material soldered on. They were essentially new technology and required special process evaluation and characterization by KCP. Handling procedures were incorporated to ensure that each device was individually packaged to protect the leads.

Two part types were received: 107 of the first device were available in production stores; 607 of the second device were available in hold stores.

An investigation was initiated to determine the ES&H rating of these special resistors.

Thick Film Resistors

The manufacturer of these devices is IRC of Boone, North Carolina. IRC was a relatively unknown supplier. Producibility ratings had not been determined on product to be procured from this supplier. ES&H status had not been determined. There were no known supplier viability problems.

Capacitors

SA2054 and SA2256

The SA2054 and SA2256 are source-accept devices. Receiving Inspection performs part counting and delivery to production stores.

There was some concern regarding mounting of these devices on printed wiring boards. The devices are subject to excessive stress build-up when soldered to boards. Solderability cannot be guaranteed within a distance of 0.050 inch of the case.

SA2775, SA2287, and SA2090

Part drawings and QER were released on the SA2775. The SA2287 had no procurement problems.

The SA2090 was expected to be unavailable for procurement by 1999. Sandia and KCP were inquiring regarding alternates for this device.

Pulse Transformer

Martin-Marietta Specialty Corporation (MMSC) was the supplier of this device. The

parts are QAIP-stamped at KCP, counted, and sent to production stores.

This device was in the process of being placed on the MDE list. Vanguard and MilSpec Electronics were possible choices as alternate suppliers.

An ES&H concern was raised as the device contains Agent Z, an ozone-depleting chemical used as a cleaning solvent in the coil encapsulation process.

Connectors

Both the SA2404 and SA2287 connectors were identified for use on MAST. The SA2404 connector had high-temperature test requirements whereas the SA2287 did not. The design agency was assigned responsibility for investigating the high-temperature insulation resistance characterization of the SA2287.

The supplier, Dale, anticipated a change from epoxy materials to Fortron plastics. Dale had been suggested as the supplier of the newer versions of these devices.

Relay

The relay is manufactured by Babcock. No inspection is performed at KCP. Devices are counted and shipped to production stores.

The existing specification required use of TCE (trichloroethylene), a cleaning agent, and Agent Z, an epoxy curing agent. A project to evaluate aqueous cleaning was being developed.

Laboratory guidance had been requested for funds to maintain manufacturing capability at Babcock.

Qualification Evaluation System Procurement Results

MAST procurement results discussed in detail above are summarized for reference in Table 1. These results represented significant effort by purchasing, quality, and engineering to meet MAST schedules. Five QERs in accordance with the Qualification Evaluation System were received and Semicoa Semiconductor was qualified as a new WR supplier.

An additional challenge for the PPTs was that MAST was essentially a success-driven demonstration program. As its schedule was resource-driven, major design iterations which were characteristic of stockpile programs could not be accommodated due to limited technical resources.

Qualification of Processes and Products Under Demonstration Programs Implementation

The introduction of Qualification of Processes and Products Under Demonstration Programs provided challenges as well as opportunities to make use of the more integrated Product Realization Team (PRT) concept. This concurrent engineering and qualification concept imbedded Quality Function Deployment (QFD). QFD is a detailed process whereby customers' expectations are clearly defined and plans developed for executing the actions required to achieve customer satisfaction. QFD's "House of Quality" requires creation of a relational matrix which correlates customer expectations with internal technology, performance metrics, organizational structure, and customer feedback. A significant number of PRT members received QFD training as suggested by the procedure.

Table 1. Closing Status of Development/Carryover Components on MAST 1

Part Number, SA Number, or Nomenclature	Device Type	Supplier	Supplier viable thru 1999?	ER Receipt/ Update Status	QER Receipt/ Update Status	ES&H Status	Comments/Concerns
SA2054	Capacitor	Kemet	Yes	Unexpected	Unexpected	No concerns	
SA2090	Capacitor	Olean	No	Unexpected	Unexpected	No concerns	Long-term availability
SA2256	Capacitor	Kemet	Yes	Unexpected	Unexpected	No concerns	
SA2775	Capacitor	Olean	Yes	Received	Received	No concerns	Procurable
SA2404	Connector	Dale	Yes	Received	Received	No concerns	Procurable
SA2287	Connector	Dale	Yes	Pending	Pending	No concerns	
1N4148	Diode	MSC	Yes	Unexpected	Unexpected	No concerns	SA3670 replaces
MT2261A	Diode	MSC	Yes	Unexpected	Unexpected	No concerns	Other funding
SA3441	Diode	Microsemi	Yes	Received	Received	No concerns	Other funding
SA3670	Diode	MSC	Yes	Received	Received	No concerns	Other funding
SA3799	Diode	Semicoa	Yes	Received	Received	None	
	IC	Harris	Yes	Pending	Pending	No concerns	No MAST CD
SA2553-1	IC	TI	Yes	Pending	Pending	No concerns	No MAST CD
SA3051	IC	National	Yes	Pending	Pending	No concerns	No MAST CD
SA3357-3	MOSFET	Supertex	No	Unexpected	Unexpected	No concerns	Harris SA3790-1 replaces
SA3364	MOSFET	Supertex	No	Unexpected	Unexpected	No concerns	Harris SA3904 replaces
SA3482	MOSFET	IR	No	Unexpected	Unexpected	No concerns	No MAST CD
SA3483	MOSFET	IR	No	Unexpected	Unexpected	No concerns	No MAST CD
SA3711	MOSFET	Harris	No	Unexpected	Unexpected	No concerns	No MAST CD
SA3712	MOSFET	Harris	No	Unexpected	Unexpected	No concerns	No MAST CD
	PFET	Micrel	No	Unexpected	Unexpected	No concerns	MDE
	Relay	Babcock	No	Pending	Pending	TCE, Agent Z	Sourced/QAIPd

Table 1 Continued. Closing Status of Development/Carryover Components on MAST 1

Part Number, SA Number, or Nomenclature	Device Type	Supplier	Supplier viable thru 1999?	ER Receipt/ Update Status	QER Receipt/ Update Status	ES&H Status	Comments/Concerns
	Resistor	Dale	Yes	Pending	Pending	Trace Cr	Over 70K ohm
	Resistor	Dale	Yes	Pending	Pending	Trace Cr	Over 70K ohm
	Resistor	Dale	Yes	Pending	Pending	Trace Cr	Over 499K ohm
	Resistor	Dale	Yes	Pending	Pending	No concerns	No MAST CD
	Resistor	Dale	Yes	Pending	Pending	No concerns	No MAST CD
	Resistor	Dale	Yes	Pending	Pending	No concerns	No MAST CD
	Resistor	Dale	Yes	Pending	Pending	No concerns	No MAST CD
	Resistor	IRC	Yes	Unexpected	Potential	No concerns	Procurability unknown
	Resistor		Yes	Received	Received	Received	
	Resistor		Yes	Received	Received	Received	
	Switch	Hermetic	Yes	Received	Pending	None	
	Xfmr	MMSC	No	Pending	Pending	Agent Z	QAIP item

Qualification of Processes and Products Under Demonstration Programs addressed a flowtime limitation of Qualification Evaluation System which procedurally required that evaluation and qualification are performed independently of each other. In addition, different aspects of evaluation and qualification may have been performed by the design agency or the production agency. This more or less sequential process had, in some cases, resulted in relatively long flowtimes. Typical evaluation activities and associated flowtimes are depicted in Table 2. A procurement/qualification PERT chart for a typical MAST 1 component is depicted in Figure 1.

In order to comply with the provisions of Qualification of Processes and Products Under Demonstration Programs, the following PRTs were assigned to support MAST 1:

- Rubber and Plastics PRT
- Purchased Ship Items PRT
- Metal Fabricated Product
- CF Cable PRT
- Purchased Products PRT

These multidiscipline teams' charter was to concurrently develop and qualify processes and products considering all life cycle elements from conception through disposal. The teams would utilize the product realization process to develop product designs based on functional criteria, determine the qualification requirements, and certify manufactured product produced by qualified manufacturing and inspection process. The functional aspects of PRT operations under Qualification of Processes and Products Under Demonstration Programs are depicted in Figure 2.

Each PRT was to consist of two levels: a multi-agency Core PRT and a Product-Level PRT. Team memberships consisted of the following personnel.

Table 2. Typical Qualification Evaluation System Flowtimes

Activity	Flowtime (Weeks)
Component Selection	16
Initial Procurement	20
Characterization	26
Create Product Definition	1
AER (Advanced Engineering Release)	1
CER (Complete Engineering Release)	2
Characteristics and Development Report (C&DR)*	20
Qualification (QS)	4
Qualification (TMS)	16
Total Evaluation Flowtime Range	70-82

*This report is prepared in parallel with other activities and is not included in flowtime computations.

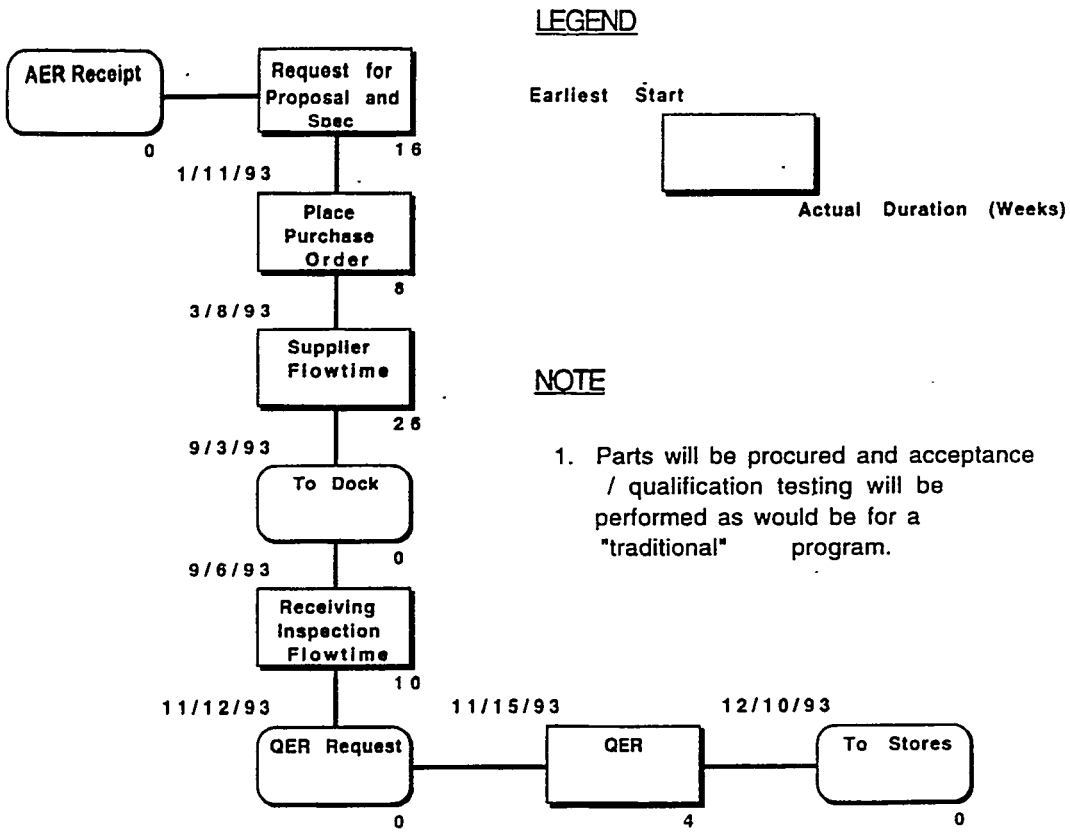

Figure 1. Typical Flowtimes for a MAST 1 Component

Core PRT

- Design Agency Engineer
- Design Agency Quality Engineer
- Production Agency Project Leader
- Production Agency Quality Engineer
- Program Management Planner (Planners are neither required nor excluded under the provisions of Qualification of Processes and Products Under Demonstration Programs. However, their involvement tended to enhance operational aspects of the process.)
- DOE Representative (Observer)

Product-Level PRT

- Design Agency Engineer
- Design Agency Quality Engineer
- Production Agency Product Engineer
- Production Agency Quality Engineer

From an operational standpoint, the PRT approach offered some advantages over the traditional procurement methodology. All team members were involved to a high degree in information sharing and feedback, thereby bringing about more practical design approaches for manufacturability and better understanding of manufacturing and design

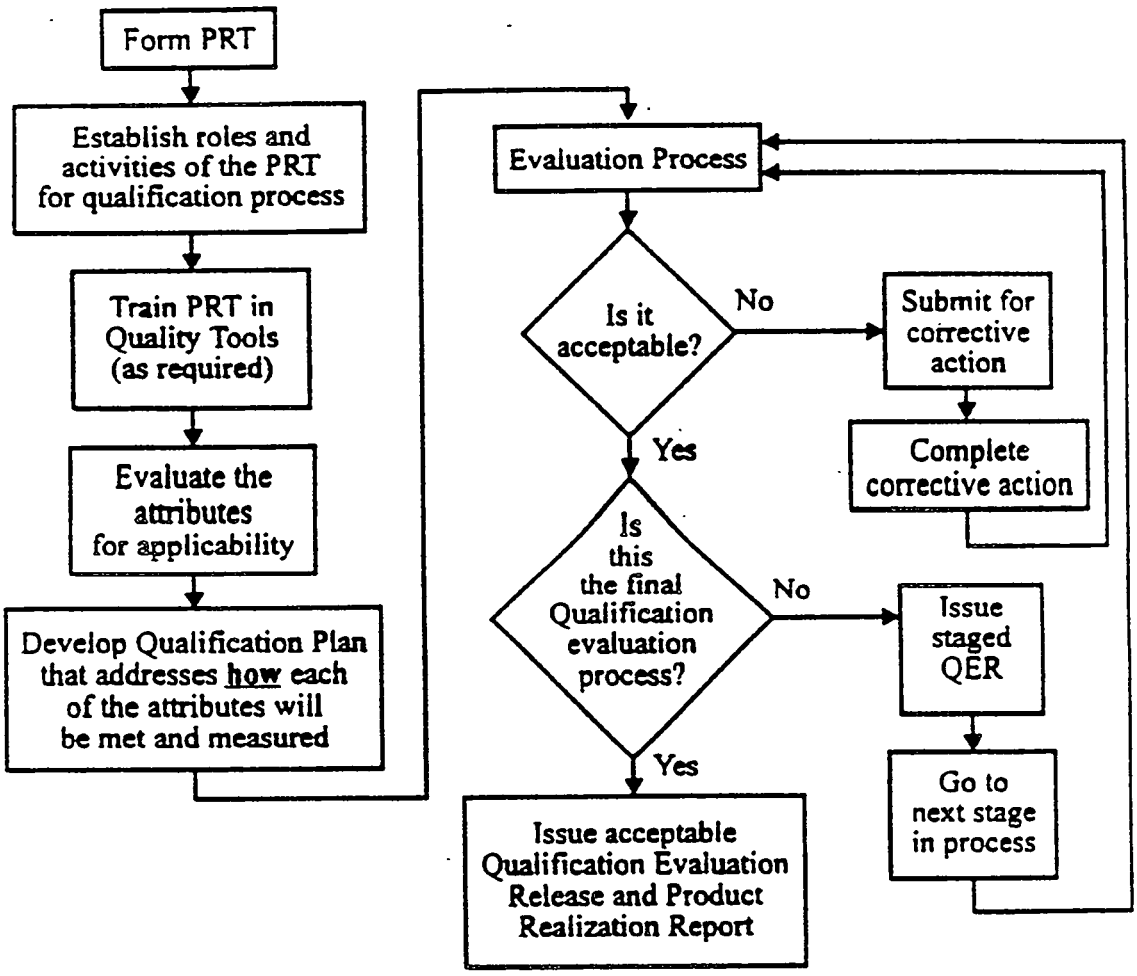

Figure 2. Functional Aspects of the PRTs Operating Under Qualification of Processes and Products Under Demonstration Programs

intent. This relationship translated into team cohesiveness and synergy.

A significant challenge was addressed in overlaying the PRT structure over the existing PPT structure. The Core and Product-Level PRTs dealt primarily with assembly and assembly schedule issues. The PRT approach was to raise Purchased Product issues if there were problems at the component level. This approach is consistent with that used in the traditional procurement process.

At the same time, however, there were instances whereby immediate feedback from the component-level engineers was extremely valuable to both the Core and Product-Level PRTs. As a solution, temporary or "ad hoc" positions were recommended with a Product Leader and a Purchased Material Quality Leader representing component-level product

and quality engineers, respectively, within the Product-Level PRT. This recommended relation is depicted in Figure 3.

Successful MAST experience with the PRT concept indicated that both evaluation and qualification aspects could be improved using this approach. An unexpected benefit was the significant impact that timely communication could have on operational aspects of the program. Continuing involvement by the Systems (Program) Engineer as a communications focal was determined to be critical to the flowtime reduction attributes of the PRT concept. This communications model is depicted in Figure 4.

Accomplishments

Traditional procurement activities in accordance with Qualification Evaluation System were initiated with significant aspects of the WR procurement system exercised.

The Qualification of Processes and Products Under Demonstration Program concept was exercised to the extent practical. Training in the Quality Function Deployment "House of Quality" is a recommendation of that concept. As a result of this recommendation, a significant number of PRT members were exposed to this training.

As a result of participation in PRTs, a significant degree of cohesiveness and synergy was developed among the PRT members. This development was seen as a model for improved communications which has the potential of significantly reducing flowtimes.

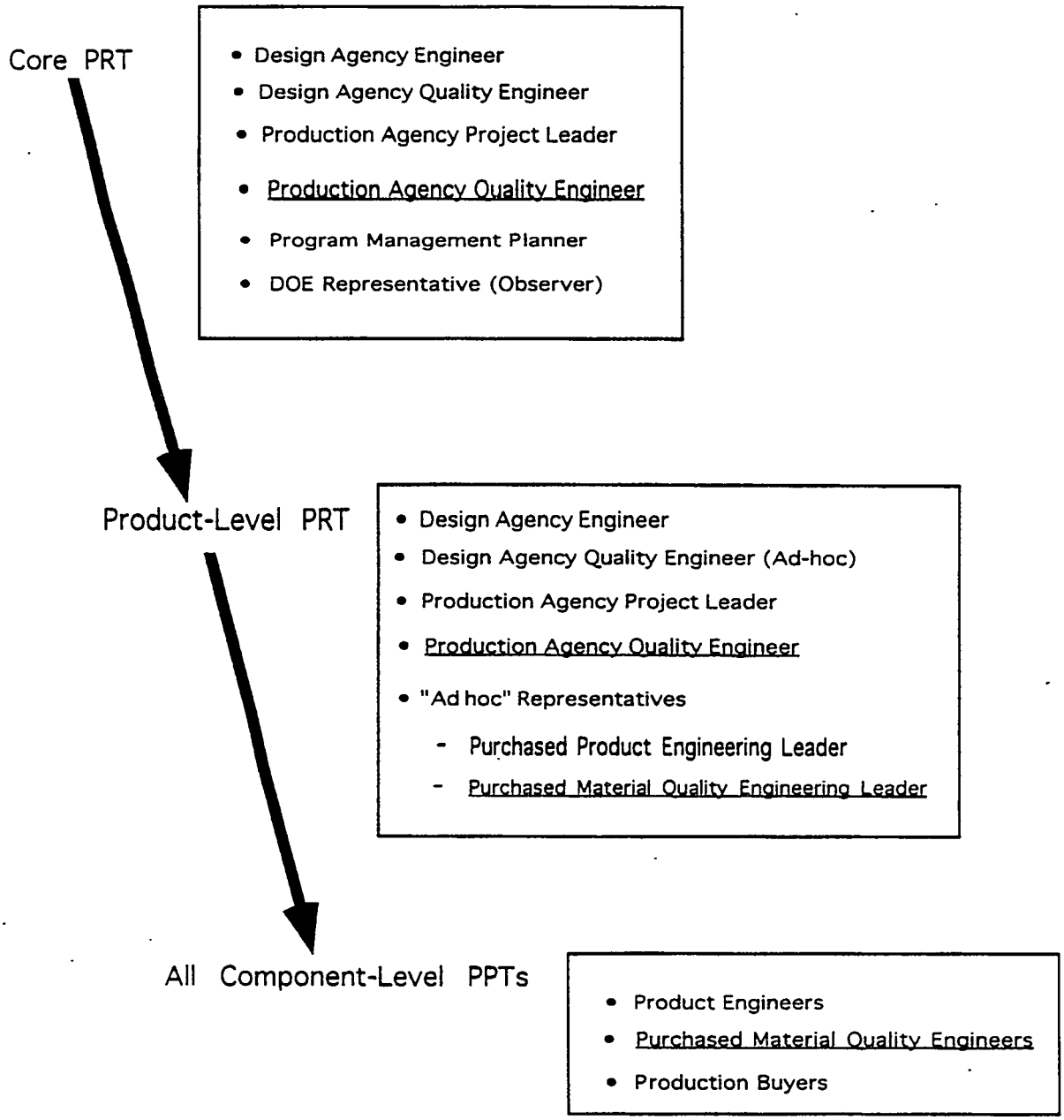

Figure 3. Component-Level Involvement in MAST Product-Level PRT

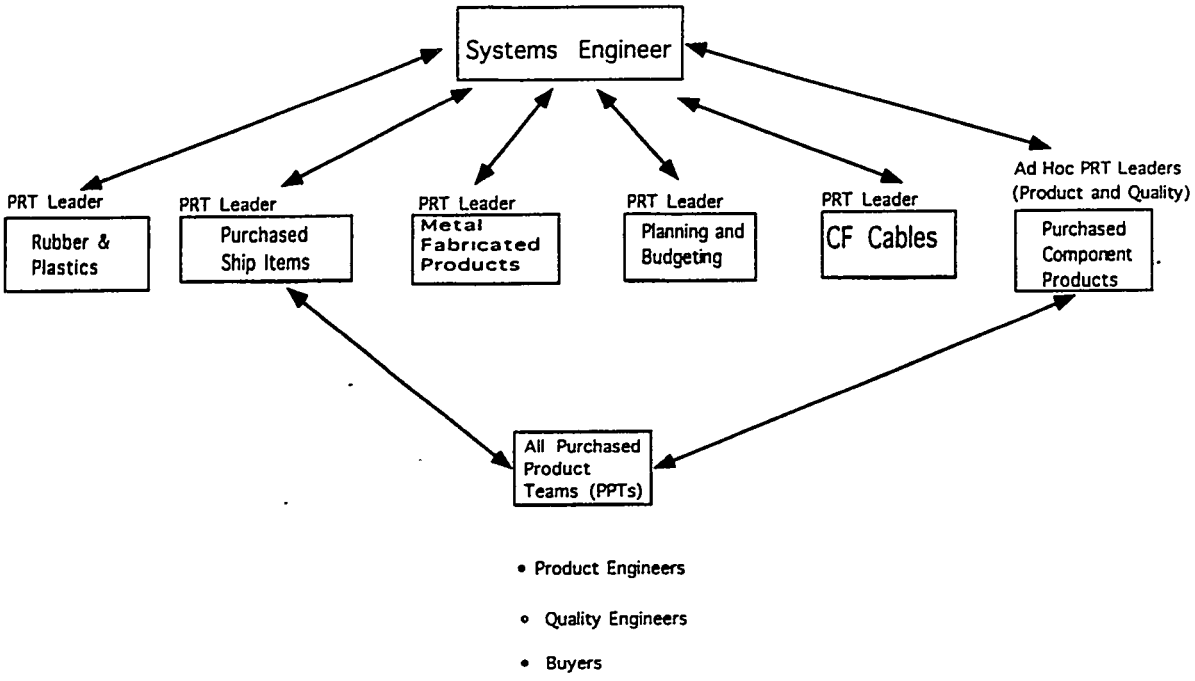

Figure 4. Conceptual Production Agency Reporting Structure for Demonstration Programs