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On the Developing of the Quality Assurance System+

— Achieving Reliability in Purchased Equipment —

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ABSTRACT

Very little work has been done in the design of process with purchased equipment; therefore, it is the intent of this project to expand the current application of reliability considerations to purchased equipment. The procurement of equipment in a manufacturing system which has both qualitative and quantitative aspects.

I. INTRODUCTION

Equipment purchased for a manufacturing system has great impact on the performance of that system, and issues such as reliability requirements should be considered during the design of the manufacturing system.

Many years of research and applications have been committed to the designing of reliable products, but very little work has been done in the design of processes with purchased equip

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ment.

There are four components of facility reliability: (1) Reliability must be quantified in terms of probability, (2) successful performance must be defined, (3) the environment in which the equipment will operate must be specified, and (4) the required operation time between failures must be specified.

Each component is applicable to purchased equipment as well as equipment designed internally. This paper expands the application of reliability considerations to purchased equipment. Specifically, a standardized methodology for procuring equipment which meets or exceeds reliability requirements is established, and computer tools are being developed which aid the manufacturing engineer in the procurement of equipment for a manufacturing system.

Ⅱ. PAST RELATED WORK

Although there exists no documented evidence which directly satisfies the requirements of this project, many articles have been identified which support the logical processing of the procurement of reliable equipment. Specifically, the reliability analysis of complex systems is an essential aspect of the purchase of reliable equipment. [2], [10] and [12] provide insight regarding the analysis that should be utilized in the procurement process.

The logical process of procuring equipment for a manufacturing process should include the objectives of a complex system. The specific issues that should be considered are found in [3], [9], and [15]. The final decision to purchase equipment from a particular vender should be made carefully, and guidelines supporting this process are found in [7], [8] and [14]. Additionally, vender quality assessment[16] and warranty concerns[13] should be addressed in the procurement process.

Ⅲ. APPLICATION OF AN EXPERT SYSTEM

Additionally, a review of expert systems via Harmon(1988)[6] and Waterman(1986)[17], was performed to determine the feasibility of using an expert system shell in this project. The appropriate application of expert systems requires that various questions be addressed. In Waterman(1986)[17], it is recommended that the following questions should be addressed: (1) When should an expert system be considered and will it work for the given problem, and (2) why choose an expert system in place of a conventional program?

Based on the descriptions above, expert systems are appropriate for this project and will be implemented in the project.

Ⅳ. A PROCUREMENT PROCEDURE FOR PURCHASED EQUIPMENT

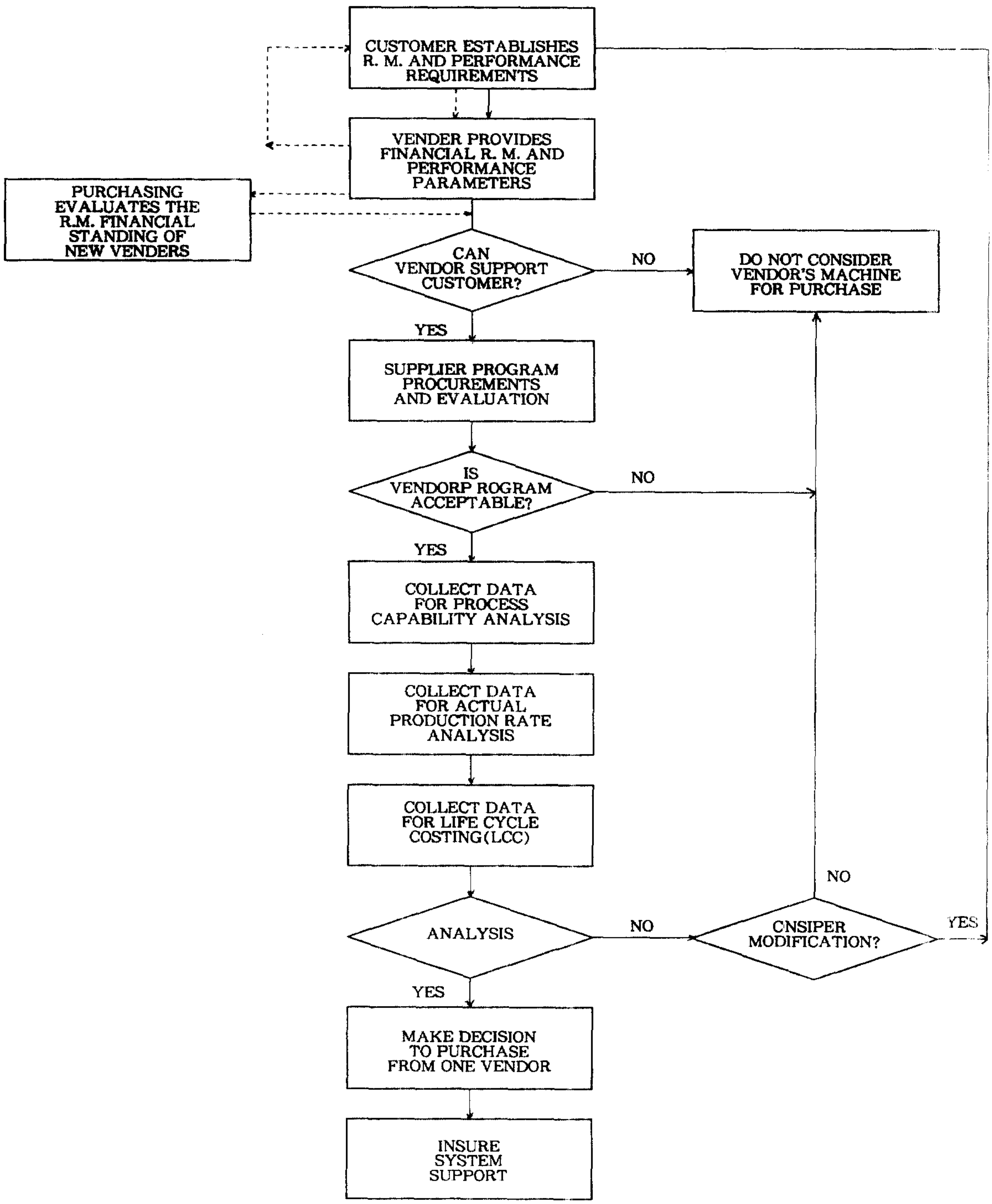
<Fig. 1> presents a detailed flowchart leading the customer through the purchasing process while taking into consideration reliability implications. It presents the macro-view of the procurement process, from the statement of initial performance requirements and parameters, through the vendor screening, data collection, data analysis, and decision to purchase. System support follows the decision process which ensures that predicted reliability performance is satisfied.

The first phase of the procedure requires that the customer establish reliability, maintainability, and performance requirements for a particular manufacturing application. This may include reliability targets such as Mean Time Between Failures / Mean Time To Repair(MTBF/MTTR). As an example, IBM's specifications[4] are 200 hours MTBF and 2 hours MTTR(200/2). The customer may include environmental guidelines, penalties for late shipments, warranties, and service guidelines[5].

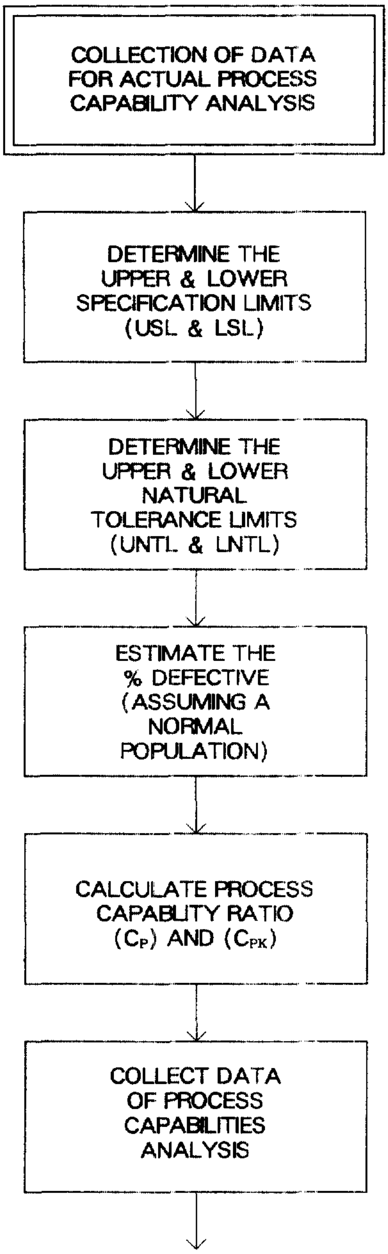
The vendor responds with anticipated ability to meet the customer requirements. This requires labor evaluations and a checks on the vendor's financial stability by the purchasing department. The vendor should supply data on the design of the machine and the internal technical skill of their company. Furthermore, the vendor should supply data pertaining to the impact the machine would have on the environment. In this phase, assurance of sufficient packaging is essential[5]. Further communication may be required as negotiations continue between the customer and vendor.

Once negotiations are completed and a potential vendor is selected, the supplier's Quality Program is evaluated as shown in <Fig. 1>. This effort provides the customer with pertinent information regarding the vendor's quality control programs, available technical assistance, quality history, and ability to deliver the product on time. The customer must make a decision regarding the potential suppliers' quality program. Concessions allowing supplier to augment existing quality programs should be considered. If the supplier cannot satisfy the customer, the potential supplier should be dropped from consideration.

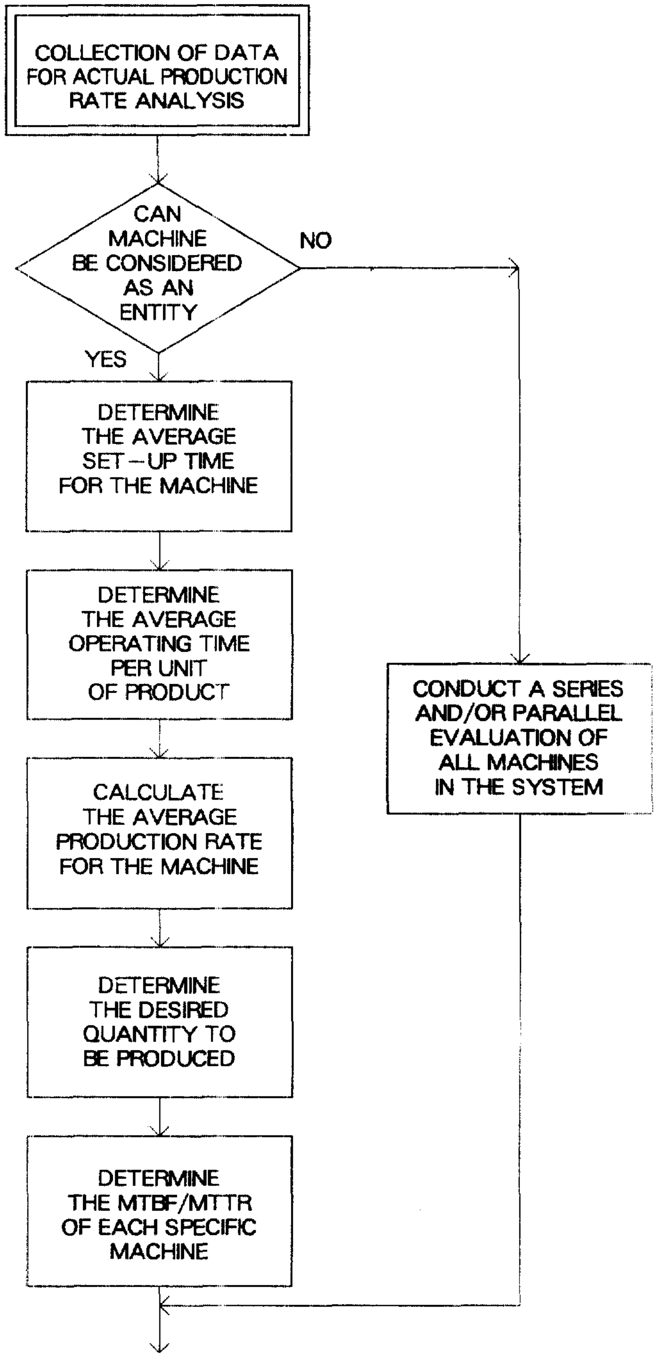
The evaluation of the supplier's quality program requires that data be collected for the process capability analysis(see <Fig. 2>).



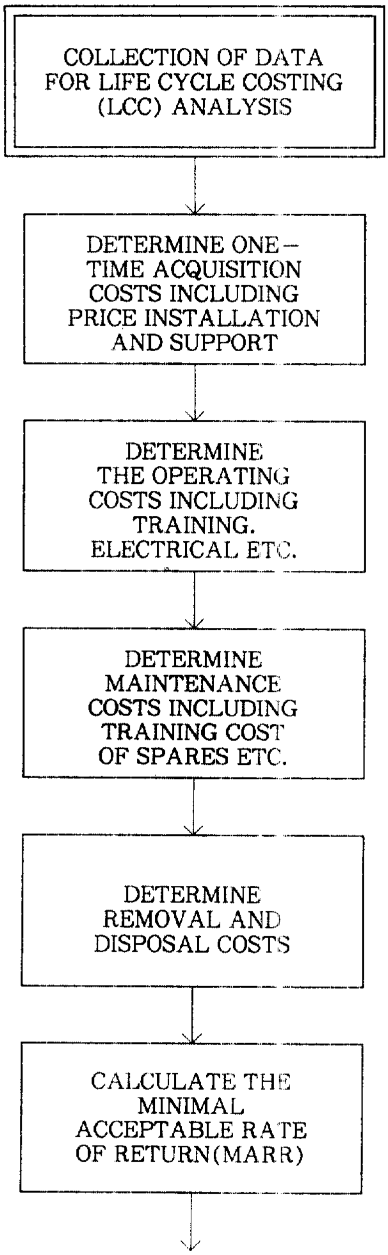
<FIG. 1> OVERALL PROCEDURES FOR ACHIEVING RELIABILITY IN PURCHASED EQUIPMENT



<FIG. 2> PROCEDURES FOR ANALYZING THE SUPPLIER'S ACTUAL PROCESS CAPABILITY



<FIG. 3> PROCEDURES FOR EVALUATING THE SUPPLIER'S PRODUCTION RATE



<FIG. 4> PROCEDURES FOR ANALYSING THE LIFE CYCLE COSTING

This analysis includes the determination of the upper and lower specification limits, upper and lower natural tolerance limits, estimation of the percent defective, and calculations of critical indices(Cp and Cpk). The vendor should provide the data supporting their process capabilities analysis.

In the next phase, data are collected for the analysis of the production rate(expanded in <Fig. 3>). If the machine can be considered as an independent entity, average set-up times, average operating times per unit of product, and average production rate are required for production rate determination. Additionally, if the machine cannot be considered as an independent entity, a system evaluation will be required to determine the system production rate and the impact of the equipment in question upon the system.

The final data collection block shown in <Fig. 1> consists of collection data for the Life Cycle Costing(LCC) analysis (expanded in <Fig. 4>). The first step determines the one-time acquisition costs, including the price of the machine, installation, and support. The second step requires the customer to determine the operating costs(training of the users, utilities costs, etc.). Thirdly, the maintenance costs must be considered (training, cost of spares, monitoring costs, etc.). At the end of the machines useful life, removal and disposal costs are in curred. In support of the complete analysis, the minimal acceptable rate of return(MARR) should be determined.

Once the data collection is completed, an analysis of the potential vendor is performed(<Fig. 1>). Such techniques as Failure Mode and Effects Analysis(FMEA), Fault Tree(FT) and Reliability Block Diagrams, and the use of min-cuts to determine the probability of failure, may be required in support of some or all of the process capability analysis, production rate analysis, and life cycle costing[12].

If no vendor satisfies the requirements, the customer must consider whether modifications in their requirements can be made. If modifications can be made, the process begins again, otherwise no purchase is made.

Once the decision to purchase from one vendor is made, the customer must ensure that all the requirements in the decision to purchase are met by the vendor. This may include the warranty agreements, vendor maintenance agreements, penalties for reliability and maintainability targets not being met, late deliveries, etc.[5]. The customer must share data with the vendor on the reliability and maintainability aspects of the machine(s) that were purchased. This will create an improved relationship between the vendor and supplier.

V. CONCLUSION

The procedures outlined in this paper provide a general framework in which a customer may evaluate potential suppliers of equipment. This evaluation takes into consideration reliability implications within the complete procurement process. Most of the quantitative aspects of the analysis exist in modern technology, but unfortunately, few advances have been made in their inclusion within a single system. Within an expert system framework, a prototype of this procedure is developed and it is anticipated that improved reliability performance of purchased equipment will be realized.

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