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Lessons Learned by the Army Materiel Command

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During the last five years, the U. S. Army and its contractors have experienced cost and schedule problems of significant proportions. In a number of instances, these problems surfaced only during production start-up or well into production.

About two years ago, Gen. Richard H. Thompson, the commander of the U.S. Army Materiel Command (AMC), assigned me the task of ferreting out root causes by spending time with contractors and their subcontractors. As one might expect, the underlying causes turned out to be rather complex. They were found at all levels of an enterprise. The material presented in this article is a collection of issues, the sum total of which, fortunately, does not exist in any one company. The findings are divided into four parts: Management, Engineering, Manufacturing, and Subcontractors and Parts Suppliers.

One of the key issues encountered in the management of some companies, especially in the electronics sector, is that production is viewed as an extension of the engineering laboratory. Consequently, these managers do not plan for or provide adequate resources for production.

Most strategic plans encompass marketing and engineering but do not include planning for future factory needs. Thus, the factory is asked to produce today's product with equipment representing yesterday's technology. The results are major inefficiencies. Machinery used to produce today's weapons cannot adequately hold the required tolerances. Resultant rework and reject rates are too high, causing unacceptably high costs.

Worse yet, the problem will be even greater when the next generation of weapons comes along. Successive generations of weapons differ in technology by 10 to 15 years. Major changes in manufacturing processes and capital equipment are necessary to meet the demands of new systems, but single year procurement policy discourages major capitol investments. Thus, the contractors do not make the investments that would achieve substantial improvements in producibility.

Another problem encountered is the lack of organizational and physical separation of laboratory activities and production. These two functions have totally separate objectives; i.e., production facilities should not be used for laboratory work. In the laboratory, the objective is to solve design problems. In manufacturing, the objectives are to produce an item on time, within cost, and to acceptable quality standards.

Too often, one encounters situations where the experience gained on one program is not transferred to the next program and that is within the same company. The Army has to pay for the learning process again and again.

Companies spend good money for the development of procedures. Then top management assumes that they are being followed. The loop is not closed because there is no audit function, or it is not effective where it does exist.

Engineering

In engineering operations, systems architectures are not developed in sufficient detail, and interfaces between line replaceable units (LRUs) are inadequately defined.

Insufficient emphasis is given to the budgeting of tolerances of the functional parameters. Adherence to this concept is an absolute necessity to assure interchangeability of all replaceable parts and subassemblies. How can one adequately specify LRU test equipment or prepare a complete interface specification without properly budgeted tolerances?

Designing for producibility has been consistently neglected, addressed too late, or ignored completely. At least 60 percent of avoidable manufacturing costs are created during the design phase.

Nor has much thought been given to the methods of inspection and testing and how they need to be accommodated in the equipment design. An example is the early identification of test points so that they can be incorporated in the design of the device.

The issues discussed above are the most significant causes for engineering changes during production start-up. Having passed the final engineering test merely attests to the fact that the specified performance requirements can be met. One must recognize that every part used in production, from system to system, is slightly different even though within specified tolerances. The stack-up of the tolerances in each system is different and can be such that a performance function can indeed fall outside the specified limits. This is a statistical fact. Tolerance budgeting is extremely important to achieve interchangeability.

Recently, I had the opportunity to visit a company that produces cameras. Before they enter the market with a new design, they make a pilot run of 5,000 cameras to assure design maturity. Then they still expect 5 percent to be returned during the first year of full production. Now, we all know that, except in the case of conventional ammunition, we will never have production rates and runs of comparable size. What can we and should we do to achieve greater design maturity earlier to achieve better producibility and get better yield during production?

We must build the requirements into our development contracts and convince our contractors to:

- Develop and maintain throughout the design: system architectures for hardware and software, flow charts, block diagrams, timing charts, power distribution diagrams, inspection and test plans (in-process), tolerance budgeting, interface specifications, specifications for in-process test equipment, and system modeling and optimization routines.
- Operate a producibility engineering program that focuses on both the producibility of the design and the factory that is needed to make the product. These are two separate issues. To achieve the objectives of these issues, the contractor has to have qualified manufacturing engineers on the design team. Moreover, it does not stop there. Quality engineers must be included as well as procurement people. The latter are needed so that, up-front, the vendor base can also be given time to prepare itself for the upcoming production requirements. The objective is to achieve design-to-unit production cost.
- Identify all critical manufacturing processes at all levels, make sure they are fully understood and demonstrated during engineering development, and make sure that methods are devised to prevent them from going out of control. Included must be a requirement for full documentation.

This appears to be a long and costly shopping list. But the costs of these efforts are small compared to those that will arise from not making the up-front investments. They will pay huge dividends during production.

Manufacturing

As pointed out earlier in this article, in many instances manufacturing has suffered from the lack of attention by senior management.

In general, production control and material management are a part of the manufacturing operation. The people in these organizations are responsible for translating the contractual delivery schedule and the bill of materials into detailed shop schedules and material requirements. They have to start by breaking down a deliverable item into the sequences of operations for the manufacture, inspection and testing of every part, subassembly and the end item. From that breakdown, they must establish the cycle time (setback chart) that starts with the release by engineering and extends through final acceptance test. Included must be allowances for the preparation of requisitions, obtaining vendor quotes and negotiations of price and delivery, receiving, incoming inspection, stocking, material draw, kitting and queing times at every operation. However, the cycle time is meaningless unless the standard times used for the manufacturing operations are realistic and scrap and rework are taken into consideration.

This information now needs to be translated into a line-of-balance chart or its equivalent. It is imperative that this effort be carried down to the lowest subassembly. Now one knows when every part is needed at every step in the process. The chart also provides the tool for controlling the manufacturing operations, namely when material should be ordered and should be available to start the fabrication process.

Too often, schedulers are not sensitive to the fact that the delivery information provided by purchasing may be an average time true for the class of parts, but does not apply to the specific part used in the system; e.g., a specialty item that is an exception to the rule. Changing economic conditions can also have a significant effect on deliveries.

Consistent tracking of schedules during the entire purchasing cycle is imperative. In many instances, expediting is started only during the last 30 or 60 days preceding the start of final assembly. The lack of understanding of the importance of proper scheduling and expediting is an underlying cause of the contractor's inability to reach rate and maintain production schedule.

There is a decided lack of communication between management and the worker, especially between the foreman and his crew. Span of control may be an issue. In many instances, though, the worker is not told what is expected of him both in terms of rate and quality. He is not given the opportunity to make suggestions for improving the process he is using or the operation that he is performing.

Processes are not properly documented and controlled. The consequence is that when the process is lost, a major effort is required to reconstitute it. That, of course, puts the project schedule in jeopardy.

Material Review Board (MRB) actions yield a wealth of data that are either ignored, not understood or not used. For example, in the case of an in-house fabricated part, disposition is to either scrap, rework, or accept as is. The probable causes for scrap or rework are sloppy workmanship, poor tooling, worn-out machinery or an engineering requirement beyond the capability of the existing process or available equipment. Where too many parts of a given part number fall into the "accept as is" category, a drawing change is the solution. Properly understood and administered, the data coming out of the MRB can be very useful in eliminating unnecessary delays and costs.

On each project, the contractor has developed standard repair procedures that are completely valid across many or all contracts. A considerable amount of paperwork can be eliminated by an early-on review of all previously used and potentially applicable repair procedures and their approval for use on the project in question.

The name of the game in production is to eliminate exceptions. Scrap, engineering changes, MRB actions and rework are all exceptions and, therefore, an unnecessary expense. They don't go away by themselves. Like everything else, they have to be managed.

Parts Procurement

This activity is divided into two parts, material and parts procurement, and subcontracting. The least-addressed and least-worked issue is anticipatory expediting. Too often, expediting is not started until the day the part is due on the receiving dock, or worse, at the assembly line. Sole-source parts, those parts for which there is only one supplier because of the proprietary nature of his product, automatically should be considered high risk because of total dependence on one source. Usually, the number of parts falling into this category is small and, therefore, requires a relatively small effort.

The blind use of certificates of compliance without incoming sample inspection and testing can be a real trap.

Reference has been made to the loss of a process. When this problem occurs and there are an insufficient number of alternate qualified sources with adequate capacity available, the highest level of management must give full attention. The resources needed to bring the process back on track usually are beyond the limits of authority of the immediate management in whose area the problem occurred. Speedy solutions may require technical assistance not available in the division and/or capital expenditures beyond the limits of authority of the division general manager.

Subcontracting

Many subcontractors are relatively small companies, possibly companies that are in receipt of the largest production order they have received since they have been in business. They have thin financing, limited technical resources and little experience in setting up and operating a manufacturing facility. Often when they get in trouble, they don't know it until they are knee deep in it. The prime contractor has to be on the alert for the possible development of such an issue and has to be prepared to jump into the breech. In the past, the prime has relied too heavily on the government. When the prime contractor enters into a contract with the government he assumes responsibility for managing his subs.

Not infrequently, the engineers of the prime contractor, in preparing the performance specification for a subcontract, tighten the requirements excessively when passing them down. Now, if the tolerance budgeting had been done properly, this problem would not arise.

During the last several years, some of our contractors have gone offshore to obtain parts and other specialty items. This tactic to reduce cost contains another risk element that we have not had to deal with in the past. The falling dollar can create a loss for the offshore supplier, which can easily outweigh the expected savings resulting from going offshore. There are techniques to prevent this reversal, but their use depends on the degree of sophistication of the offshore supplier in dealing in transactions involving currency exchange rates.

Conclusion

What has the AMC done to overcome the problems we've encountered? We have:

1. Created a Directorate for Production to give production appropriate recognition and attention.
2. Created the position of assistant deputy for production with the express assignment to work the most serious production issues.
3. Established the requirement that every major program have a complete acquisition plan prior to the start of the project. The plan includes the requirements for producibility engineering and planning (PEP) and a design-to-unit production cost during the development cycle.
4. Redefined PEP to include design for producibility, the development of new manufacturing processes and work to reduce high risks in manufacturing.
5. Vigorously supported continuation of the Atlanta conferences.
6. Held a series of meetings with top-level corporate executives.
7. Held a one-day seminar on parts management.
8. Established PRIDE (Production Review Integrated Database).

The list is not intended to be all-inclusive but is an example of the actions AMC has undertaken to overcome the problems discussed in this article. ■

The author is the assistant deputy for production at the U. S. Army Materiel Command, where he provides technical advice on production to the commander and deputy commanders and initiates corrective actions on major production deficiencies. He has been on a number of national committees and has been a guest lecturer at several institutions of higher learning. He spent over 30 years with Westinghouse and E-Systems, where he held management positions in engineering and manufacturing. He holds a B.S. and M.S. in mechanical engineering. He is a director of CASA/SME and chairman of Autofact '87. He is a recipient of the Army's Decoration for Meritorious Civilian Service.

AMC Commander's Message

I've been the commander of the U. S. Army Materiel Command (AMC) for almost three years now. During that time, I've spent close to 60 percent of my time on the road visiting AMC installations and activities and the commands and units that use the materiel that we in AMC develop, buy, field, and support. I also speak frequently to industry groups and, whenever possible, visit with management and tour plants and other facilities. In 1986, I was able to make 21 industry visits that gave me an across-the-board look at how the U. S. defense industry operates.

While I see some good, tight operations, and I am able to observe quality planning and procedures that give us quality products, I often see the opposite as well. Then the result is real frustration—frustration because costs and schedules get out of control. As a customer, I want what I ordered, in the quantity and quality I contracted for, and when I expect it. When I'm a satisfied customer, we all benefit. I don't like the idea that the taxpayer, the Congress, and, especially, the soldier might think that we don't know how to manage and fulfill our mission.

Because the percentage of AMC's contractors is of such great importance, we've made a number of substantive moves to focus more fully on all aspects of production. As an example, I created the position of assistant deputy for production, which is now held by Fred Michel. He spends over 90 percent of his time away from AMC headquarters, working directly with management on engineering, production and supply, and parts problems. He has put the observations he has made through his extensive time with industry into this report. He has presented his views to AMC's program, project, and product managers and to other AMC and Army audiences, but I feel that his insights and perspective will be of great value to members of the American Defense Preparedness Association as well.

I want to stress that our comments, although generally negative, are presented in a most positive spirit. Improvements you make in your ability to fulfill your contractual obligations to us are good for all of us. In addition, we are well aware in the Army Materiel Command that we have much to improve in our own operations. In fact, in my view, our list of negatives surpasses yours, and we are vigorously working to do better.

What I hope to stimulate is a healthy dialogue much like the exchange we experienced at the Atlanta Conferences. The more we talk frankly and constructively, the better we will meet America's materiel defense needs. I welcome any comments and suggestions you might have.

As a final and related note, I want to take this opportunity to ask for your support for a new organization focusing on finding solutions to our country's productivity and competition problems. The National Center for Manufacturing Sciences (NCMS) is a private, not-for-profit consortium of small and large manufacturers from a variety of U.S. industries. Their goals are to advance the state of manufacturing science and foster the development of manufacturing processes, tools, and techniques.

I'm encouraged by this initiative. I think that by combining their talents and experience, the consortium's members will make significant contributions to American industry's search for ways to improve our productivity rates and competitiveness in world markets. I know, too, that this group's efforts will benefit the Army Materiel Command as we work to support our American soldiers.—Gen. Richard H. Thompson

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You may obtain information on the National Center for Manufacturing Sciences by writing.

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