PRODUCTION ENGINEERING

# STEPS TO A SUCESSFUL AUTOMATION PROJECT

*Article courtesy of the AMT*

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# Introduction

Dramatic changes in the needs and expectations of consumers have forced a revolution in the ways manufacturing is done. This revolution has created ever-increasing requirements for rapid responses to changing manufacturing requirements. Increasingly, such market challenges are being met by the application of custom automated systems, productive enough to assure optimum unit costs, yet flexible and agile enough to respond quickly to change. Many companies have already made, or are now making, that transition. This booklet presents checkpoints and some do's and don'ts that will enhance your chances for both economic and technical success in customized systems.

Consider the impact of factors such as these on manufacturers:

- company's strategic business decisions to increase market share and/or to develop new products and take them to the market in as short a time as possible. The importance of being a market leader in the face of global competition.
- The ability to respond rapidly to changing customer requirements and niche opportunities.
- Regularly capitalizing on advances in manufacturing technology.
- Maintaining a competitive edge, even in times of turbulent and shifting global economics.
- Developing optimum manufacturing processes brought upon by dynamic changes in your

Production supervisors or managers at more than 15 manufacturing companies, each with extensive experience in using custom automated manufacturing systems in their own operations, have shared, for this report, their suggestions, perspectives, and some warnings. They have shared their experiences so others could be more productive. That is the purpose of this booklet ... to help walk you through a process, from start to finish, to assist you in successfully incorporating automated manufacturing systems designed specifically to meet your unique needs.

# I. When and Why Automate

A. **MARKET DRIVEN:** CHANGED REQUIREMENTS OF CUSTOMERS/MARKETS.
B. **STRATEGIC BUSINESS DECISION**: NEW PRODUCTS, INCREASED MARKET SHARE AND OTHERS.

The following are some objectives to be accomplished by automating
*(In no particular order because each situation is different):*

1. Ability to accommodate timely production changes.
2. Higher quality with greater consistency in the manufacturing process.
3. Reduced costs.
4. Need for greater capacity.
5. S. Reduce the time to "go to the market".
6. Greater responsibility as a "value-added" supplier.
7. Enhanced safety-ergonomic factors.

It is nearly universal that those companies moving to custom automation are doing so in response to customer requirements. As one said: "We do not invest for extra capacity or to try the latest technology without first assessing the needs of the market or the competitive environment. If our customers don't need it, we don't buy it. If they do, we'd better get it or someone else will." Here are comments from others:

"These moves are driven by what we perceive (or are told) is a market need, as opposed to building a baseball field and hoping. In this industry with tight margins, we do not invest in speculative capacity. Almost all capacity needs are driven by strategic business objectives to either increase market share or introduce a new product."

*- OEM products manufacturer*

"Marketing dictates to us what the market is asking for, both in terms of product and in terms of anticipated volume requirements. Volume requirements, by the way, should be carefully evaluated. If they are 'realistic' or conservative, consider assuring yourself that capacity can be added easily and economically, in the delightful event that the product succeeds. Consumer demand forecasts can easily understate what happens once the market actually takes to the product in a big way."

*- Consumer products manufacturer*

"When our major customers began to ask us for more 'value-added' products that included some subassembly, we changed from a job shop parts maker into a full-blown first-tier subcontractor. We had to have a flexible manufacturing system to produce the variety of components and to remain cost and quality competitive - and to grow!"

*- OEM component supplier*

# II. Where Do You Start

ANALYZE AND DEFINE THE COMPANY'S LONG-TERM BUSINESS OBJECTIVE; MAKE CERTAIN AN AUTOMATION INVESTMENT IS IN LINE WITH THAT OBJECTIVE. IF SO:

1. Design - define the function of the product(s), the volume to be produced (or cycle time), the size(s), the basic contours and quality requirements to be produced by the system.
2. Select a project team to work with vendor representatives. (See Step III for elaboration on the makeup of this team.)
3. Before detailed engineering is completed, call in selected system vendors, first, for any suggestions they might have on product(s) design modifications that would make automated manufacturing simpler and less costly, and, second, to learn how they would preliminarily define an appropriate process and approach a system solution. At this point, the company may see some benefits of working with a vendor to do concurrent/simultaneous engineering on certain product design features. However, it may be more difficult and costly to work closely with multiple vendors on these details at this stage.

Those with systems experience universally stress that the work and planning done at this stage can make or break the success of a project, or, at a minimum, reduce the need for changes and added costs during the subsequent steps in the project development. Several relevant comments:

> "Probably the first maxim regarding automation is that the product must be designed so it can be automatically handled and that the tolerances can be consistently produced. It's costly and nearly impossible to replace the dexterity of the human hand for manipulating, the human mind and senses for locating, and human attention and experience for assurance that 'all's well'."
>
> *- Systems builder*

> "The biggest sin of prospective users is that they have not given enough attention to be able to handle and position the product in an automated system. If you are going to automate a family of parts, choose the members of the family that can be put through the system with minimum changeover - and pick those most likely to attain high volume production based on market demand. You probably can better afford a less automated, off-line process for the low-volume, tough-to-integrate parts rather than attempting to integrate them into the automation."
>
> *- Automatic handling equipment producer*

# III. Who Gets Involved

A TEAM OF USER EMPLOYEES IS SELECTED, REPRESENTING ALL FUNCTIONS INVOLVED IN THE PLANNING AND OPERATING OF THE SYSTEM TO BE DEVELOPED.

1. A Project Manager is essential to head up the team throughout the entire process, right into production, to ensure continuity of understandings and commitments. This person will be the communications contact with his counterpart at the systems builder.
2. Representatives must be included from manufacturing, engineering, quality, marketing/sales, and finance.
3. Persons from the plant who will be responsible for setting up, operating, and maintaining the system must be active participants.
   See Exhibit: The Project Team

This is another step in the evolution of the system which will be key. The success of the project is greatly affected by the knowledge of the representatives of both user and vendor, and in their cooperative relationship. Several comments:

"It is critical that you get the vendor contributing ideas in the early stages of product design. They are the system specialists and they can suggest ways to make the product simpler to manufacture and, thus, save you wasted money and time. Time and effort must be spent up front in the project to develop those alliances and trust factors way ahead of time."

*- Consumer products manufacturer*

"There is no overstating the importance of the qualifications of the project manager; the more that person knows about manufacturing, the better. That person must also be a good administrator and communicator, guiding the team of specialists, including design engineers, manufacturing engineers and managers, purchasing representatives, operating and maintenance personnel from the plant, etc. This person also then becomes the lead person for all communications with the vendor's project manager."

*- Manufacturer of heavy industrial and commercial products*

"Once we have the product and the process defined, we bring in the people who will run the systems, so they have an opportunity to suggest ways we could make some changes to make the process easier to use, or to maintain, etc. At the beginning, I can say that you greatly enhance your odds for success if you have (or get) three things: First, a project manager who knows the product and knows the appropriate manufacturing operations; second, knowledge of the builders whom you invite to come in to help, and third, a feeling of 'ownership' by the users team."

*- Consumer products manufacturer*

# IV. Selecting the Supplier

DECIDING WHICH COMPANY WILL BECOME YOUR SUPPLIER BECOMES A MATIER OF TRUST, COMFORT AND CONFIDENCE.

1. If you know the field, pick the builder with whom you feel most comfortable.
2. If you do not know the field, check with other companies that have similar operations. Even competitors often share their vendor experience. AMT - The Association For Manufacturing Technology (see address on back cover), can furnish a list of custom system builders for you to consider.
3. Make certain that your choice has the experience, the technical expertise, and the manufacturing capability and capacity to build the system. Learn this by taking your team to visit the various builders' plants, compare strengths and weaknesses, check out financial status and experience level, assess shop loads/schedules, visit builders' recent installations, conduct reference checks, etc.
4. Present the broad specifications of the project to a select few builders you identified after completing item 3 above and request system concepts and rough cost estimates.
5. Analyze the various builders' proposal concepts, ideas, ballpark prices and delivery to determine which company has the best understanding of your needs and compare this with the data collected in item 3 to make your final selection. To assist in this analysis, prepare a detailed matrix of all the issues (tangible and intangible) that must be compared and develop an appropriate "relative weighting factor" for each issue.
6. As the final selection is made, remember the key to a successful automated manufacturing system is a trusting and respectful relationship between the builder and the end user, in essence a partnership, where people are committed to resolving problems and finding answers that are mutually beneficial.

Since the first-time investor in custom automated systems has little experience to count on, the vendors consulted must have that experience and must be asked to contribute suggestions regarding the manufacturability of the product and the system they would propose. In the end, the choice will be the one in which the user has the most confidence. It is wise to select the system builder as early in the program as possible to do simultaneous engineering - to become a partner even in the design stage. This early involvement can considerably reduce the amount of time it takes to get into production.

"Typically, we will have been working with two or three suppliers. So then it's a matter of who can do it when and at what cost. As soon as we start getting into the specific systems proposed by the companies we're dealing with, that two or three will go to one in pretty short order, based largely on which company and which people we feel most comfortable dealing with. Then, it becomes a joint development effort in terms of how to get there the quickest and most economical way, while still meeting all of our objectives. This also is the time when the system is described in detail. The schedule of events that will occur during the completion of the project is outlined, and the price is determined. Agreements between supplier and customer will be reached regarding the responsibilities of both companies for such items as employee training, plant preparation, warranty and service policies, and other items that will be listed later in the purchase contract."

*- OEM products manufacturer*

"How do you pick a partner? You must have somebody that has experience with a similar product, to shorten your learning curve. They must be financially sound, have the technical horsepower to answer questions and to solve our problems. Eventually, it becomes a personal choice of the one company that can best meet our job requirements, and in our time frame."

*- Product subassembly contract manufacturer*

"We tell the vendors what we need to do, and then ask them for ideas and for questions. Eventually, we identify those two or three vendors that have experience in the direction we need to go. We select those on the basis of their capability in terms of project organization, engineering proficiency and manufacturing capability, and we ask them to make proposals. Finally, we pick one, and that vendor assumes total responsibility for the success of the system. and for the quality and function of subsystems such as controls, feeders, transfers, electrics, etc."

*- Consumer products manufacturer*

"Getting a supplier who is a specialist in our type of operation is essential. We've been working with one builder on a project in which we have had to increase our capacity twice. Each time, the builder has come up with new ideas. For example, at first we specified a cycle time of 1200 parts an hour, but when one station went down, it all went down. We now have specified a system throughput of 900 an hour, and with queuing at the right places, we can depend on it. Result: a 20 to 30 percent increase in overall performance."

*- Automotive components manufacturer*

"What do I expect of a system builder? SPC capability: we shoot for a specific $C_{pk}$ on critical dimensions, in-house capability to make and design the tooling, and turnkey responsibility of purchased elements. We also look for somebody that has project management skills - where they can define the project from start to finish, with a person qualified to see the project through, and to maintain constant contact with the project manager at our plant."

*- Consumer products manufacturer*

# V. Defining the Solution

NOW THAT YOU HAVE SELECTED THE COMPANY TO BUILD YOUR SYSTEM,
IT'S TIME TO ROLL UP YOUR SLEEVES JOINTLY AND REALLY GET DOWN INTO THE DETAILS ... ALL THE DETAILS.

1. Develop the process - the sequence of operations to be performed - in specific details.
2. Specifically define quality requirements, citing those dimensions and/or surfaces that are critical.
3. Define the required minimum throughput (productivity and expected operating efficiency) of the system.
4. Consider the approximate floor space required, and evaluate your ability to accommodate it. Determine whether any special plant preparation (e.g., foundation) is required for the system installation.
5. Define and agree upon the criteria to be used to accept (buy-off) the system on the builder's floor and at final installation.
6. Consider the impact of OSHA and other regulations and provisions.

This is where joint discussions between the user and the supplier's team analyze the design of the product(s) to be produced, required quality levels (particularly on critical features), the required productivity of the system, acceptance criteria and other pertinent requirements. Comments:

"At this point we define the product's tolerance range, and then develop what should be specified in terms of the system's process capability over a run of X amount of hours, depending on the production rate. Experience has shown us that a certain $C_{pk}$ will assure us that the processes natural tolerance range will be less than the specified product tolerance range, th.us making the process 'capable' and 'in control'. In addition we find out how the vendor will meet our quantity requirements, plus any other suggestions for system features and for other factors that we agree are essential to the success of the system in our plant."

*Automotive Components manufacturer*

"We know a great deal about how our products ought to be processed. Now we learn how it will be done automatically, what we need to do to accommodate automation, and, perhaps most important, how we assure specified quality is within the system's capability at production rates. Customers are requesting to see that we have documentation according to ISO 9001. To compete in the marketplace we've got to have all of this quality."

*- Product subassembly contractor*

"Transporting workpieces from one working station to another in an automated system must be considered as a vital part of the system decision; it must be considered at the same time that processing steps and sequence are determined - and that time is when the products to be manufactured are being engineered."

*- Material handling manufacturer*

"You want the industrial automation team in on the ground floor, before engineering is completed. We can take a look at what the needs are, and we often can simplify the system and make certain the proper controls and electrics are chosen for the job."

*- Electric and electronic control and monitoring systems company*

"A warning, based on our experience: during the process development stage the worst thing that can happen is the 'might-as-well' syndrome- where you begin to think that 'as long as we're doing this, we might as well' add this or try that. Pretty soon you over-engineer everything, and your costs soar. The solution is to work with the vendor to establish a very robust technical boundary. If it doesn't fit in your original objective, don't do it. If you keep on adding features and other criteria, pretty soon you have a boy scout knife - it does everything, but it does nothing well."

*- Manufacturer of heavy industrial and commercial products*

# VI. Justification

"MANY MANUFACTURING COMPANIES ARE NOW BEGINNING TO RECOGNIZE THAT THEIR CURRENT COST JUSTIFICATION APPROACH IS NOT ADEQUATE, PARTICULARLY IF THEY ARE CONSIDERING SIGNIFICANT INVESTMENTS IN ADVANCED AUTOMATION. THEY ARE REALIZING THAT AN IMPROVED APPROACH IS REQUIRED THAT WILL ALLOW TIIEM NOT ONLY TO EVALUATE AUTOMATION AS IT IMPACTS THE READILY QUANTIFIABLE ASPECTS OF THEIR TOTAL BUSINESS, BUT VIEW IT AS A STRATEGIC WEAPON THAT CAN BE USED TO ATTAIN LEADERSHIP IN OUR NEW GLOBAL ECONOMY."

This quotation is taken from a 46 page document entitled *Investment for Competitiveness - Cost Justification*, published by AMT - The Association For Manufacturing Technology. This document was prepared for companies searching for more sophisticated analytical cost justification techniques including purchasers of advanced automation systems. The following are additional excerpts from the AMT publication:

**"THE BENEFITS THAT CAN BE OBTAINED FROM AUTOMATION INVESTMENT ARE NOT WELL UNDERSTOOD."**

"Many CEOs and other members of general management have financial, legal or marketing backgrounds and may not fully understand the implications of automation. The financial people who are often responsible for analyzing capital investments often do not fully understand the implications either. Those with manufacturing or engineering backgrounds, who might be more likely to understand and favorably receive automation projects, are often perceived as having self-serving interests. The result of these divergent viewpoints is that intangible benefits, the least understood, are often ignored in many evaluations, viewed as standard boilerplate depending on the nature-of the investment, or held suspect."

**"CAPITAL INVESTMENT PARTICIPATION: CLASSIFICATION OF BENEFITS"**

"The issue of measurement, traditionally and narrowly defined as the quantification of benefits, is further complicated by the very nature of the task itself."

"Benefit assessment must be performed simultaneously along two different dimensions to produce meaningful results as shown on the next page in the Classification of Benefits grid. In the simplest case (Quadrant I) an automation benefit, or cost, can have very tangible characteristics that make quantification relatively precise so that the underlying value can be derived through conventional means."

"The issue of measurement becomes more difficult as benefits become less quantifiable and more tangible in nature (Quadrants II and ID). In the most difficult case (Quadrant N), benefits that are predominantly intangible not only make definition of the expected benefit vague, but also make strict quantification of benefits nearly impossible."

| | **QUANTIFIABLE** | **NON-QUANTIFIABLE** |
|---|---|---|
| **TANGIBLE** | **Quadrant I**<br>• Material cost reduction<br>• Labor savings<br>• Inventory reduction<br>• Scrap/waste reduction<br>• Increased capacity | **Quadrant II** *(Generally cost related)*<br>• Setup reduction<br>• Elimination of non-value added activities<br>▪ moves<br>▪ inspection<br>• Reduced manufacturing lead time<br>• Reduced administration cycle time<br>• Increased plant safety |
| **INTANGIBLE** | **Quadrant III** *(Generally revenue related)*<br>• Increased flexibility<br>• Improved quality<br>• Increased market share due to new product/innovation<br>• • Price premiums due to shorter lead times | **Quadrant IV**<br>• Improved employee morale<br>• Improved work environment<br>• Ability to attract better employees<br>• Better skilled employees<br>• Perceived technology leadership by customer<br>• Customer requirements satisfied<br>• Regulatory requirements met |

"In reality, excluding intangibles results in no value being assigned at all. In actual practice, their less than rigorous inclusion most often produces a relatively low value as compared to benefits traditionally viewed as quantifiable or hard savings."

"Intangible benefits, however, which are not so easily quantified, must be clarified. These benefits impact important success factors in the market place and must be considered when evaluating automation investments."

Intangible benefits are most typically associated with investments in automated manufacturing systems. A more complete, but not exhaustive list can be found in the AMT document along with specific techniques, various models, detailed case study examples and much more. **A copy of *Investment for Competitiveness - Cost Justification* can be obtained by contacting AMT's Publications Clerk at (703) 893- 2900 (there is a $10 charge for the publication).**

"The ability to respond to changes in high-volume business, and to produce a continued high quality level of product, at a certain cost target, drives automation in our business. If we were to do these operations manually, we would not be assured of constant quality, no matter how skilled our workers are - at best, human performance varies, even though in small increments. Thus, the assurance of quality has a high value to us, justifying the investment. The same is true for assured production and cost levels."

*- Electrical and electronics products producer*

"Flexibility supports our goals of customer satisfaction, investment efficiency, and world-class timing. Flexibility will allow us to reduce product design and changeover time for new products and lower incremental facilities and tooling investment for mid- cycle changes and future programs. Establishing manufacturing flexibility as a parameter is an integral part of all future production. This ensures that the long-term benefits from flexibility, through the product or equipment life cycle and across programs, are included as part of the financial analysis. First, the financial analysis should factor in the benefits of flexibility, including downstream investment or other cost savings, specifically if the up-front flexibility is projected to reduce expenditures for the next cycle and derivative products and/or across product lines. Second, for product changeover, proposals that provide flexibility offer savings as a result of reduced downtime and can generate added profits from incremental sales resulting from additional capacity. Third, for major programs, recognize financial benefits for incremental sales resulting from increased flexibility by being able to respond to swings in market demand."

*- From a recent in-house publication at a major automobile company*

"We do a market survey to see if the product we are considering will have an adequate market, and, if so, what volumes will we need. Based on that information, the project team projects the capital investment required to meet the needs. We then do a financial analysis that calculates the return on assets. The equipment cost may well be a very small portion of the project. Often the R&D cost would be, by far, the most expensive portion. If we will need substantial capacity beyond current manufacturing and final assembly lines, then that all has to be taken into the equation. Manufacturing effectiveness and quality usually rule the decision."

*- Electronic machines and systems manufacturer*

# VII. The Contract

IN Addition TO THE USUAL TERMS AND Conditions, THE SUPPLIER AND END USER MAY WISH THEIR CONTRACT FOR A CUSTOM MANUFACTURING SYSTEM TO ADDRESS A NUMBER OF ISSUES, INCLUDING:

1. A sign-off on all technical descriptions of the system, including appropriate engineering drawings;
2. Production rate of the system, at specified efficiency levels;
3. Final part drawings from the customer and definition of required levels of accuracy/quality;
4. Required capability of the system to hold tolerances over a period of time, stated in one of the several standard index terms, such as standard deviations (Sigma) and $C_{pk}$;
5. Specified progress and milestone points throughout the building schedule (possibly using a Pert, Gantt or similar plot) at which time builder and customer decide whether a meeting is needed;
6. Agreed-on statements regarding safety, noise and other plant environmental considerations;
7. Training requirements for operation and maintenance.
8. Other important specifications to be addressed:
    a. The project price;
    b. Delivery date;
    c. Criteria for acceptance of the system at vendor and at customer including the quantity and quality of customer supplied parts required for set-up and run-off of the system and method for inspecting/gaging quality;
    d. Names of selected suppliers of components or subsystems (tools, controls, electrics, etc.);
    e. Procedure for handling system changes after initial order, if required by customer, and if the changes have costs associated with them, how the charges will be billed;
    f. A list of recommended spare parts to be purchased which may be developed by the builder at the appropriate time and presented to the customer;
    g. Warranty and service policies;
    h. Documentation/manuals required by customer.

It is typical, as well, to consider inclusion of provisions that the builder train the user personnel in such things as system setup, programming, operation, maintenance, tooling, etc., and that a preventive maintenance schedule be included. Additionally, some have said:

"Our contract is a multi-page document. It includes both our commitments and those of the systems builder. We throw in all of the normal legalese, but we then specify our agreements as to individual stations, number of spindles, transfer system, test or monitoring operations, etc. Also established is an agreed upon list of suppliers of tools, controls, electrics, hydraulics, et al. These are negotiated prior to the agreement, and in some cases we accept the preference of the builder. As for performance, we stipulate the conditions for and the extent of the runoff in the builder's plant and our plant as part of the contract."

*- Automotive components manufacturer*

# VIII. Monitoring the Project

DEVELOPING A PLAN FOR THE PROJECT IS TYPICALLY A JOINT TASK BETWEEN THE PURCHASER AND THE BUILDER. SUCH A PLAN MAY INCLUDE SCHEDULES FOR PERIODIC PROJECT REVIEWS INCLUDING SUCH TASKS AS:

1. Process planning;
2. Design engineering and design review;
3. Component manufacturing;
4. Sub-assembly;
5. Final assembly;
6. De-bug time;
7. Final runoff;
8. Training;
9. Installation and startup.

The two project managers, one at the user's plant and one at the builder's, should be in continual communication about the progress, and any problems that arise, during the evolution of the project. To maintain continuity, it is highly advisable that both of these project managers stay with the project throughout the entire process. The two parties should also consider adoption of a Gantt or Pert chart, or some other appropriate method, to monitor the schedule. Comment:

"In addition to keeping track, we always want to keep the builder apprised of any new developments or changes we wish to make. For example, if I change a hole size slightly, I'm going to let my counterpart at the builder know it immediately. This kind of communication is critical. Whether you can meet your schedule and your budget depends greatly on good communication at this stage. And then I strongly recommend that all obsolete prints be destroyed! Somehow, if any are left out there they will come back to haunt and to cost you."

*- Heavy industrial and commercial products manufacturer*

# IX. Training

THE BUILDER AND CUSTOMER WILL WORK TOGETHER TO COMPLETE TRAINING FOR THE USER'S SELECTED EMPLOYEES.

1. All operational aspects including setup and any changeover procedure;
2. Electronic/computer programming;
3. Trouble shooting and repair service training;
4. Preventive maintenance schedule;
5. Manuals and other forms of documentation.

Since every person interviewed for this document commented on the importance of training, there is no need to add a long list of quotations for it. The systems builder and the customer together will decide what skills need to be learned, how many and to what depth. For the first round of personnel, it may be best for the training to be done at the builder's plant, so when the system is installed, user employees can be watching and checking their knowledge rather than starting from scratch. Training, of course, may also be agreed to be done at the user's plant after installation.

The user may wish to assure that only trained personnel operate and maintain the system. If the people that were initially trained transfer out of this project, the user may wish to consider the advisability of training the new employees.

# X. Runoff and Acceptance at Supplier

THE USER AND THE BUILDER HAVE AGREED THAT THE SYSTEM WILL BE TESTED IN A RUNOFF AT THE BUILDER'S PLANT. THE INTENT IS TO PRE-APPROVE AND ACCEPT THE SYSTEM AT THE BUILDER'S PLANT ACCORDING TO PREVIOUSLY AGREED UPON CRITERIA. AGAIN, SOME OF THESE FACTORS MAY INCLUDE:

1. System productivity - cycle time;
2. System capability to maintain part quality over a predetennined run;
3. Changeover time, if system is to be changed for a family of parts;
4. A significant factor to the success of the runoff is that the customer should provide the previously agreed upon quantity and quality of parts;
5. Other factors as previously agreed.

Perhaps these comments give a feel for it:

"One of the things that we don't do enough of is allow time for an adequate run-off at the vendor site. Typically, the runoff is a time line-driven thing rather than an engineering-driven thing, where time becomes the dominant factor, rather than the quantity and quality - a major error. The same thing applies to runoffs during startup in your plant. Acceptance criteria are clearly spelled out in the contract - that goes from the first-part dimensional features; it goes to a process potential (X number of pieces in a row), then to a $C_{pk}$ of key features that are pre-selected, and you're basically looking at the dimensional integrity of the product and of the capability of the process to hold those tolerances. Then analyze the overall performance of the system. Does it meet rates, efficiency, and changeover times? When all of those criteria are met, then we go into an acceptance run, which is usually an 8-hour (shift) run, split up over multiple sizes and variations, so you can exercise any tooling changes and any length variations -- get the small, medium and large of the parts you're going to run. A good runoff is essential to the success of production in the user's plant. In a way, it is the proof, and the only proof that matters, that all of the work that has preceded it in the program has led to a satisfactory performance."

*- OEM products manufacturer*

"As for the length of the runoff, I would think at least 32 pieces, because SPC would say that would give me a 97% confidence level. For smaller parts, and short cycles you may want to run many more. I would expect that the builder has done a runoff, because he knows that I expect our runoff to be successful. The entire project team from our plant attends this runoff including those responsible for project design, manufacturing process, quality acceptance, plus those in our plant who will run, set up, maintain and program changes when needed."

*- Manufacturer of heavy industrial and commercial products*

"On a cycle time of 1200 an hour, we specify an eight-hour runoff."

*- Consumer products manufacturer*

"Our normal specification is for a specific $C_{pk}$. We also include our supplier runoff of 24-hour dry cycle, and then a day's worth of parts, furnishing us with the $C_{pk}$ data for that run."

*- Automotive components manufacturer*

# XI. Installation, Final Acceptance and Production Startup

After the system is installed at the end user (during which time the builder often only supervises), the final acceptance run generally occurs to repeat the same acceptance criteria used at the builder. Once this is satisfactorily completed, the system is ordinarily accepted and turned over to the customer to start actual production.

Despite a successful final acceptance, the customer's staff should demonstrate their readiness by putting the system into production (with the builder's assistance). Notwithstanding warranty and service agreement coverage, most builders are eager to have the customer running smoothly on its own before leaving the plant.

# Closing Comment

In truth, this list of eleven steps and various end user comments may make the whole process sound foreboding. It is not! These steps, or similar ones, have been taken successfully by all of those who commented and many, many more. What is here is, simply, a logical sequence, some do's and don'ts, and some guideposts to success. The counsel of experienced systems builders can go a long way to assuring success.
Remember, the key to a successful automated manufacturing system is a trusting and respectful relationship between the builder and the end user, in essence a partnership, where people are committed to resolving problems and finding answers that are mutually beneficial.

# Exhibit

**THE PROJECT TEAM**

This is the "committee" assigned to define the manufacturing needs, and to work with the system builder during the life of the program.

**Project Manager:** This person is key to the success of the total project.
Competency in manufacturing is essential. Most important are the management skills that will successfully coordinate the balance of the team. This person will also be the key communications link between the user and the builder's counterpart.

**Product Design Engineer:** During the transition from concept to reality, this person will represent the product plans, and will take part in discussions regarding part design modifications needed to automate production and achieve required quality levels.

**Process/Manufacturing Engineer:** This person assists in identifying and analyzing proposed solutions for potential success, and compatibility within the existing facilities and work force.

**Operation:** Plant supervision and the persons who will be responsible for scheduling, setting up, controlling, operating and maintaining the system will have invaluable input regarding the actual operation features of any proposed system, and on how to make it more "user friendly."

**Others:** Purchasing people can help in contacting suppliers; financial persons can help monitor costs vs. return; quality personnel can help define tolerance and process control quality levels, etc. After the supplier has been selected, consideration should be given to having someone from the supplier participate with the end user's project team.