A Discussion on Successful Automation

The leadership team at Dynamic has had the privilege of visiting over 80 potential clients over the last several years. Sadly, we have found a consistent undercurrent of distrust, disdain, and outright suspicion toward Integrators. The objective evidence for this situation is usually an expensive (but useless) piece of equipment collecting dust in a forgotten corner of the factory, where the guilty object of corporate shame rests until the "depreciation sentence" is served. This issue is so pervasive, we decided to write a white paper on the topic. The intent of this paper is to ensure the of success of new projects, and (hopefully), make the process efficient and enjoyable for all parties.

Notes:

1. Although it is customary to write white papers in third person, this example is written primarily in first person in the hope of stimulating actual conversations with clients, or potential clients. As such, this document will evolve over time as feedback is given and integrated.
2. We wanted to name this paper "Why People Hate Integrators" but decided not to. 😊

About Dynamic: Dynamic has its roots in Medical Device Design and manufacturing, as well as Aerospace manufacturing. We have more than 20 years of experience in Medical Device product and process development, and 15 years experience in Aerospace manufacturing/maintenance/refurbishment. The salient point is that we fully understand the OEM development and manufacturing environments, having spent many years in both. Summary – we've been on both sides of the automation/integration process – as an OEM seeking automation, and as an Integrator providing automation to an OEM.

Improving the Odds: The most successful automation projects have a single point in common:

Well understood, defined, and documented project requirements and objectives.

There really is no substitute for this. A thorough User Requirements Specification (URS - also sometimes referred to as Equipment Specification) is extremely important. This best URS documents are developed by a cross functional team that includes representation from each of the following groups:

- Operators who actually make the product
- Operations Managers
- Manufacturing Engineers responsible for the process in the operations area
- Maintenance Managers (or staff)
- Purchasing/Sourcing
- Quality Engineering and Quality Assurance
- Safety/EHS

Each of the above players has a unique view on the candidate process, and a single observation or recommendation from any of them can make the difference between success and failure of a project.

A common (and sometimes fatal) flaw in the development of URS/ES documents is lack of established precedence or examples of what is needed. Additionally, the priority given to these documents is often not the primary responsibility of a single individual, rather responsibility is spread out over several individuals or

groups. The result is often gaps in the requirements that cannot be addressed at a later date. This problem is often exacerbated by individuals inexperienced in implementing automated equipment into manufacturing processes.

Consider the following RFQ Scenario:

OEM: I need a box to hold my product after it's built.
Integrator: Excellent! We can build any style box you would like.
OEM: Glad to hear it. How much will it cost and when can you deliver it?
Integrator: We will be happy to provide lead time and pricing, can you tell us what the box needs to do?
OEM: It needs to hold XYZ product.
Integrator: OK, how big is XYZ, and how many do you want the box to hold?
OEM: (sigh), It's 12 by 16 by 32, and I need it to hold 44 of them.
Integrator: Is that 12mm, 12 inches or 12 feet?
OEM: (Sends picture)
Integrator: Thank you for the picture, but I'm still not sure of the size.
OEM: MM
Integrator: OK, thanks. Can you tell me how you want the parts oriented? Does the box need to isolate the parts? What are the parts made of?
OEM: Upside down. Yes. Metal.
Integrator: Which side is down?
OEM: The bottom.
Integrator: Um, can you point it out in a drawing or picture? Also, what are the tolerances on the size of your parts? We want to make sure the boxes accommodate the full range of tolerances.
OEM: That sounds like a lot of work. I'm not sure we have tolerances on them. When will you have the quote? I need to have this submitted by tomorrow.

This conversation may seem silly, but this scenario plays out in many projects. Unless it is provided, there is simply no way for the integrator to have all of the necessary information to succeed in delivering what the client wants. The amount of detail, tolerances, non-specified operator and product variability, environmental and chronological factors can make the difference between success and failure. The integrator cannot know these things unless they are specified formally in a URS/ES document. This is why the cross functional team on the OEM side is so vital. There are often many sources of unspecified variability that are not commonly known or discussed across an organization.

Takeaways: The amount of effort required on the part of the OEM to successfully document automation requirements is often underestimated. This problem can be exacerbated with individuals inexperienced in parametric analysis (the key to success in automation). It is very helpful when managers understand that generating specifications for automated process is a specialized skillset, and adequate resources and experience go a long way towards ensuring the success of a project.

Note: Yes, we have had clients tell us "we don't have tolerances for that part", while asking for a machine that can successfully process whatever happens to be in the upstream pipeline. It is often necessary to "reverse-engineer" tolerances to establish an acceptable/testable range of input conditions for the automation project.

Understanding Automation

First Contact: Normally, a project begins with a site visit to an OEM, and a discussion and/or tour of the area of the facility that will (or does) produce the item of interest. In the best cases, there is an existing document used to define the scope of the project, timelines, and enough details of the product and process to understand the technical challenges involved in automating the processes under discussion.

At Dynamic: Upon return to Dynamic, the project is discussed with the automation team. Conceptual system architecture, risks, and unknown inputs are identified (to the maximum extent possible). A dialogue is opened with the potential client to gather as much information about the "unknowns" as possible. Based on this dialog, a project is categorized in one of two ways: Deterministic or Developmental.

Deterministic: A project whose methodologies, control, mechanics, and implementation are believed to be fully understood to such a degree that a high probably of success (95%>)can be predicted based on known information and conditions. These projects are regarded as low technical risk. We can design, build, program, and successfully deploy this equipment with a known amount of effort (design/labor/materials). Importantly, the customer can know what to expect in terms of performance and process reliability.

Developmental: A project defined primarily by technical risks with unknown mitigations. Further, it is not known at the outset if the technical challenges can be overcome. These risks can be related to the following:

- Lack of samples
- Lack of technical specifications around anticipated production variability
- Incomplete parametric data on upstream processes, or desired process outputs
- Uncertainty of inspection methodology (particularly with vision based systems)
- Non-standard mechanical geometries (floppy/flexible parts, extremely tight tolerances etc…)
- Processing operations requiring "feel" vs. precision*
- Unknown or unavailable test methodologies

*Very common when attempting to automate processes where the product was not designed for automation during development.

Transparency - Keeping the Client Informed

It is common for projects to be categorized as Deterministic, but with some developmental risk. These are projects that will require some amount of development, but the risk is not such that it pushes the entire project into the Developmental category. There are some identified developmental challenges, but it believed that solutions will be found within the time and budget allocated.

If a project is categorized as developmental, it is expressed clearly in the ROM/Proposal process. If a project is categorized as Deterministic with some developmental risk, the risk burn-down activities are clearly defined in the ROM/Proposal process as early stand-alone milestones.

Managing Expectations

Automation is expensive. There is no getting around this. The components going into automated industrial systems have to be premium quality from known, reputable sources. The client (rightfully) expects their expensive equipment to be extremely reliable. Given this, the design, development, fabrication, assembly, and programming that goes into automated industrial equipment has got to be extremely solid as well. The automated equipment and its related process must be predictable and reliable. There is simply too much at stake to take shortcuts and make decisions based on severely restrictive budgets.

The expected reliability of automated equipment is an often-overlooked topic of discussion. On the surface, if a piece of equipment malfunctions or stops on one part out of 1000, that may not sound too unreasonable. However, if you're making 1000 parts an hour, it means that the machine will stop every single hour! It is often envisioned that "automating a process" will somehow improve process reliability. This is sometimes true. However, if an existing problem in the product design or materials is causing process reliability with operators, it may get worse with automation if the variability in the material or process is not highlighted in the conceptual phase of the machine design. Discovering these hidden variabilities after the machine has been designed/delivered is often a "deal breaker" and cannot be successfully remediated because the entire conceptual framework and architecture of the machine was built without this knowledge. It is often true that "if we'd only known" comes into play when fatal flaws or shortcomings are discovered. Again, the emphasis on thorough understanding of existing process and material conditions is crucial to successful automation.

Parametric Process Control and Predictive Engineering

To the greatest extent possible, Dynamic works to implement parametric process control into its machine concepts. The idea is to fully understand the inputs to the machine (material size/shape/variability), the actions performed by the machine, and the output conditions. This approach allows accurate predictive modeling of the machine performance during development. The more well understood the inputs, the better (and more accurately) we can model the behavior of the equipment. Adequate thought (and budget) for deliberate preparation of product samples that represent the full range of anticipated variability is extremely important to achieve the anticipated performance and reliability of automated equipment.

To the greatest extent possible, statistical tools and techniques will be applied to predict the performance and capabilities of the equipment. This approach can provide extremely valuable data to ensure success of the project. It is often necessary to request significant numbers of samples to support these activities. Please be aware of the need for (and value of) statistically significant sample sizes.

Further, it is also crucial to have samples that are fully representative of production items whenever possible. Small, unanticipated changes from pre-production samples to full production materials can change the behavior of processes and equipment to a large extent. The intent is to make sure the process and equipment works with the product that will be used in production. Experience indicates (clearly), that success with a small group of samples does not always translate to the same success with production parts. There is almost always unknown or unanticipated variability if this is not actively rooted out during development.

Gotchas

Here are a few examples of hard-lesson "gotchas" that carry significant risk for automation projects, and are completely avoidable:

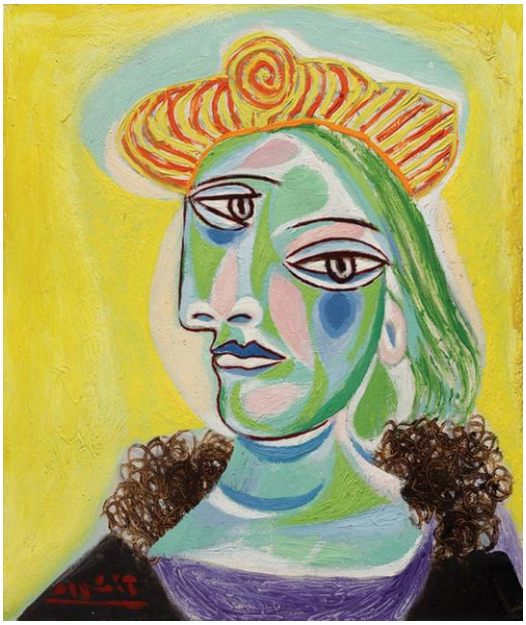
- Lack of cross-functional team support for development of the URS/ES at the OEM.*
- Lack of adequate detail and specifications in URS/ES documents (i.e. critical "need to know" information is simply omitted by the integrator or OEM).
- Lack of clear delineation between requirements (must haves), and "nice to have" features/functions.
- Unread/misunderstood ROMs/Proposals – the preliminary ROM (Rough Order of Magnitude) document or full proposal provided to the client is not fully understood. This can lead to disappointment, disaster, missed timelines, and blown budgets faster than almost any single other factor.
- Integrator or OEM team members who express "it's their problem" when discussing difficulties with automation projects. These "problems" rarely go away on their own. The relationship between the integrator and OEM has to be unusually cooperative during the project. If the project isn't successful, neither party wins. These behaviors should be seen as red flags at the OEM and Integrator.
- Adding requirements after project kickoff. As with many design changes, the earlier requirements are discovered, the better chance they can be implemented successfully without adversely impacting the project timeline or budget.
- Accessibility of the installation site. The path from the delivery dock to the machine installation site must be understood, and planned. A drawing and/or CAD model of the machine will be established well before delivery. However, if equipment or arrangement of the factory floor precludes moving the machine to the intended installation site it can create serious problems. Often the new automated equipment is delivered in a calibrated state. Disassembly of the equipment may necessitate many hours of work to re-establish the correct operating conditions.

*Experience indicates that Quality, EHS/Safety, and Operators are most often excluded from document reviews.

About Budgets

To state the obvious, projects will have budgets. Typically, several integrators will be competing for a project. All things being equal, the lowest bidder will (of course) be awarded a contract for the project. However, in our experience, all things are never equal when it comes to integration. Purchasing automated equipment has certain similarities to commissioning art. For example, you may know you want a likeness of something (described in the URS/ES), but the exact outcome (equipment design) is highly dependent on the integrator.

Example: Your Specification states "I would like a portrait of a particular young lady". You show the artist a photograph, and commission them to complete the portrait:



Picasso

Vermeer

The above specimens are both fine examples of art. However, they are very different ***interpretations*** of what the artist saw and thought you wanted. Similarly, the process of procuring custom automated equipment - by necessity - leaves control of the design of the equipment to the integrator.
The problem is that corporate purchasing policies are primarily configured towards purchasing raw materials and "off the shelf" equipment. Selecting the lowest bidder when the integrator has large latitude regarding the design of the equipment can be problematic. This is particularly true if the integrator is working to maximize profits in every way possible.

In our experience, it is most often wise to look at the competing concepts closely with the full cross functional team, and select the concept that has the highest probability of success (within budgetary constraints). If the lowest cost option also coincides with the highest probability of success, then it is a true win-win! If not, then a risk-management activity regarding budgets and concept selection would be something to strongly consider.

Mike Ferrell
Chief Operating Officer|Dynamic Control and Automation