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Successful automation projects start with well designed Control Systems

7 Steps towards your next successful Automation Project

1. Prepare a Needs Analysis document

A Needs Analysis is a one or two page document that outlines the benefits of undertaking an automation project. The benefits are prioritized according to their inherent value and grouped to form the stages in which the project is executed. The Needs Analysis includes specific measurable goals based on one or more of the Return on Investment (R.O.I.) guidelines that consist of improvements in:

a) Volume of production
b) Quality
c) Operating costs - through reduced energy consumption, space, labour
d) Safety
e) Reduced downtime
f) Reduced maintenance costs
g) Standardized parts inventory

In comparing prices for automation projects, remember that the best value is not based solely on the lowest price, but should be based as well on quality, dependability, suitability, engineering support, maintenance and operations costs.

2. Develop a Functional Specification

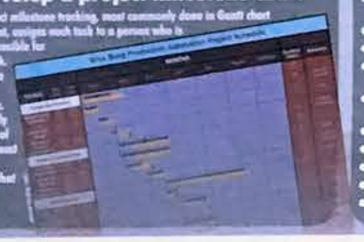
A Functional Specification defines the technical requirements of the system and the scope of the project. The document is used to derive the project's budget and to obtain management approval for the project. The Functional Specification must contain enough detail on which to base the system design and give the system integrators enough information to submit a fixed price quote on the project.

The Functional Specification should include:

- A project overview describing; the process, and/or the sequence of operation; whether the control is PLC or PC based; whether the functions contain closed loop motion control; and current or future requirement for data collection.
- Whether the automation equipment is connected to other data networks and the type and frequency of communication that is required.
- A description of any existing or other used automation equipment that is to be re-used.
- A list of materials to be supplied by the integrator, as well as a list of materials that will be supplied by the owner.
- A specific list of products that will be processed on the automation equipment including the product names, dimensions, grade, species, etc.
- Sensor and actuator details that include a brief functional description of the number of analogue inputs/outputs (I/O), the number of AC I/O, and the number of DC I/O.
- The function, quantity, size and type of all motors, drives, and pumps to be controlled, and whether they are forward/reversing, and single speed or variable speed.
- Hydraulic system cylinder and valve details.
- Pneumatic cylinder and valve details.
- The quantity, location and type of operator interfaces, and whether they are PC-based HMI, touch screens, or discrete pushbutton panels.

3. Develop a project milestone chart

Project milestone tracking, most commonly done in Gantt chart format, assigns each task to a person who is responsible for completing the task. Each task is given a start date and an estimated duration. Other tasks that rely on the completion of the previous task must not start prior to the completion of that task.



4. Obtain operator console/station layout drawing approval from operations personnel

Create electrical layout and schematic diagrams; an I/O listing; a bill of materials; an operating manual and any other relevant documentation, in order to support long term trouble shooting and maintenance tasks.

5. Perform Factory Acceptance Tests

Specify Factory Acceptance Test procedures and checklists to ensure that the system functions properly in a simulated workbench environment. The Factory Acceptance Tests should be performed by the same development and commissioning team personnel who will perform the on-site acceptance tests.

6. Key points to the successful commissioning of an automation project:

Commissioning is the period of time after the construction/installation and before the site acceptance testing. Prepare a plan that specifies the tasks, the order in which they will be performed, and the specific personnel required to complete the tasks. Deciding whom to bring in the controls specialist requires careful consideration. That person is useful to have on site to verify receipt of the proper control system components prior to installation, and to supervise some of the more unusual aspects of the electrical wiring.

Tasks to be performed before and during the commissioning phase

- Review, inspect and verify that the electrical specifications of the automation equipment are as expected prior to installation.
- Review the installation plans of the controls enclosures, operator console, junction boxes, and local disconnects prior to installation.
- Review the installation plans of the conduit and cable tray layouts prior to installation.

- Provide a clean, warm and quiet area close to the work cell where the controls specialists can debug software and solve problems.
- Arrange to have enough clean power during construction for programming terminals and diagnostic equipment.
- Verify that control power is clean and is at proper voltage levels.
- Verify sensor type, location, settings and gain adjustments.
- Verify the presence and correctness of labelling on field devices, and of labelling inside the wiring panels.
- Apply power to the control system PLC or PC with field outputs disconnected, and test for proper communication to all remote modules and operator interfaces.
- Test each I/O point for proper wiring and continuity.
- Verify that all motors are wired correctly and check rotation for proper direction.
- Test sections of the controls program with no materials in the system to verify proper program and mechanical function.
- Use the control system to start and stop all equipment, first individually and then collectively, to verify safe operation, and proper functioning of any interlocks.
- Test proper operation of all electrical disconnects.
- Verify data collection in server databases.
- Verify report display and print functions.
- Train the operations personnel from all shifts in the safe operation of the system.
- Train the maintenance personnel from all shifts in maintenance of the system.

7. Perform Site Acceptance Tests

The development and integration team should compile the Site Acceptance Test items and procedures into a document beginning at an early stage in the system development phase and should update this document as needed during the project development. The site acceptance test differs from the factory acceptance test in that site acceptance tests are specific to the field installation of the hardware. Site acceptance test procedures and documentation ensure that everyone involved is in agreement with the test results, and gives time lines for rectifying any problems for subsequent re-testing. Ideally, the operational personnel are engaged in the site acceptance testing as a form of training without the pressure of production and quality. The cost of the site acceptance test should be included in the quoted price provided by the system integrator. The time required to perform the site acceptance test should be accounted for in the schedule, and the testing should be started only when the commissioning phase is completed.

The site acceptance test checklist includes:

- I/O wiring and labelling;
- power wiring and labelling;
- hardware field installation;
- vendor literature, system operation and maintenance documentation;
- control system drawings;
- system operational function

Recommendations for a well designed control system:

Ergonomic design and selection of the location of operator controls and screen displays and comfort of operator safety and lead to higher productivity.

Keep enclosures containing wire terminations, distributed I/O, and other electronics away from excessive vibration, humidity, caustic vapours, and sources of electrical noise, in particular Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI).

The control system design and installation should implement electrical noise control measures such as:

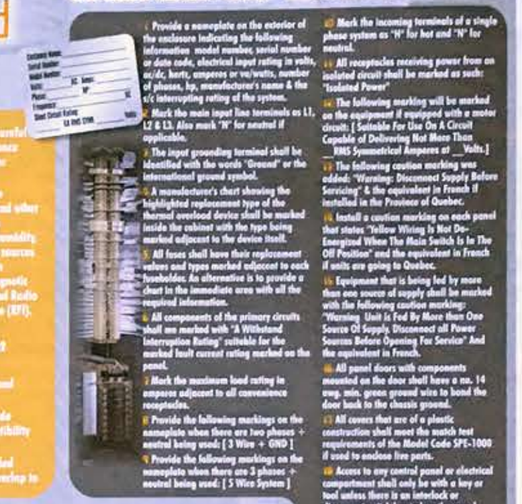
- Establish and maintain a solid ground plane for the control system components and machine structure by using appropriate bonding.
- Segregate electrical devices and wiring into clean, dirty, and very dirty zones inside electrical enclosures, based on their electrical noise generating and noise susceptibility characteristics.
- In cases where clean, dirty, and very dirty zone cables must intersect inside crowded electrical enclosures, use shielded cables or metal conduit and minimize cable overlap to reduce electrical noise coupling.
- Separate all DC voltage cables at 32VDC or less and analogue signal wires from AC cables by at least two feet, particularly where the cables run parallel. If the two types of cables must cross, arrange them so that they cross at right angles to each other. This ensures that the cables should not run in the same cable tray.
- System control power should be clean i.e. free of electrical noise, voltage surges and harmonics, by utilization of a ferroresonant power conditioner.
- Additionally, an Uninterruptible Power Supply (UPS) should be utilized to maintain supply power to the PLC or database server and other vital equipment in case of a complete power loss.
- Provision of controlled remote telephone access to the control system program by support personnel will significantly reduce delays in obtaining support services.

Trouble shooting a control system:

A general rule of thumb is to test proper functioning from the lower levels to the higher levels, and not the other way around. For instance, there is no point in determining if the PLC input module is faulty if the proximity sensor has fallen off its bracket.

- Continuously ask yourself what has changed to cause the change in behaviour - the answer may not be obvious at first.
- Were any mechanical and/or electrical changes made that could have affected the response of the system?
- Do symptoms appear only during certain operations or while processing certain materials?
- Has any equipment been installed in the vicinity that may radiate and introduce electrical noise into the system?
- Use a meter with an input impedance of 10 Mega ohms or greater to trouble shoot a control system. Avoid the use of testers that use incandescent bulbs or neon lamps to test solid state circuits.

Standards Check List:



1. Provide a nameplate on the exterior of the enclosure indicating the following information: model number, serial number or date code, electrical input rating in volts, ac/dc, hertz, amperes or va/watts, number of phases, hp, manufacturer's name & the s/c interrupting rating of the system.
2. Mark the main input line terminals as L1, L2 & L3. Also mark "N" for neutral if applicable.
3. The input grounding terminal shall be identified with the words "Ground" or the international ground symbol.
4. A manufacturer's chart showing the highlighted replacement type of the thermal overload device shall be marked inside the cabinet with the type being marked adjacent to the device itself.
5. All fuses shall have their replacement values and types marked adjacent to each fuseholder. An alternative is to provide a chart in the immediate area with all the required information.
6. All components of the primary circuits shall are marked with "A Withstand Interruption Rating" suitable for the marked fault current rating marked on the panel.
7. Mark the maximum load rating in amperes adjacent to all convenience receptacles.
8. Provide the following markings on the nameplate when there are two phases + neutral being used: [3 Wire + GND]
9. Provide the following markings on the nameplate when there are 3 phases + neutral being used: [5 Wire System]
10. Mark the incoming terminals of a single phase system as "N" for hot and "N" for neutral.
11. All receptacles receiving power from an isolated circuit shall be marked as such: "Isolated Power"
12. The following marking will be marked on the equipment if equipped with a motor circuit: [Suitable For Use On A Circuit Capable of Delivering Not More Than ___RMS Symmetrical Amperes at ___Volts.]
13. The following caution marking was added: "Warning: Disconnect Supply Before Servicing" & the equivalent in French if installed in the Province of Quebec.
14. Install a caution marking on each panel that states "Yellow Wiring Is Not De-Energized When The Main Switch Is In The Off Position" and the equivalent in French if units are going to Quebec.
15. Equipment that is being fed by more than one source of supply shall be marked with the following caution marking: "Warning Unit is Fed By More than One Source Of Supply. Disconnect all Power Sources Before Opening For Service" And the equivalent in French.
16. All panel doors with components mounted on the door shall have a no. 14 awg. min. green ground wire to bond the door back to the chassis ground.
17. All covers that are of a plastic construction shall meet the match test requirements of the Model Code SPE-1000 if used to enclose live parts.
18. Access to any control panel or electrical compartment shall only be with a key or tool unless there is an interlock or disconnect switch located on the panel door.
19. Openings in enclosures that have sharp edges or burrs shall have bushings or equivalent installed to prevent damage to the conductor insulation.
20. Fill all unused openings in cabinets, boxes, panel boards and fittings.

The information on this chart was compiled by René van Amerom, an independent consultant/contractor with over 14 years of experience in providing industrial automation solutions, primarily to clients in the forest industry. René may be contacted through his company Optimum Controls International at info@optimumci.com