Managing Large distributed projects

- and providing excellent Control Systems
- on large fast track projects.
- with and without specification modelling systems.

Author Francis Lovering ControlDraw Ltd, July 8th, 2002

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Summary

The paper discusses the issues involved in providing excellent process control systems on large, fast track Engineer Procure and Construction projects.
Excellent process control systems meet the following objectives:

- Users have the opportunity to influence the design to recognise their operating culture, and their specialist knowledge.
- The systems contain the expertise of the equipment supplier in how their equipment should operate and the process designers in how the process should work.
- Documentation is clear, understandable and accurate, so that validation is done efficiently, using data that is clearly traceable to its origins.
- Project managers have control over the design and implementation process because the process is measurable

The introduction describes the issues involved as projects increase in size and tasks are divided between suppliers. It looks at conventional methods used by most practitioners and then the paper shows how tools like ControlDraw can be used to help the complex process of succeeding on such projects.

Introduction

The difference between small and large projects

A single person can design small projects. A larger project may require a small team, to define all the functional requirements.
Many projects are too large for even a small team.
Rather than making a bigger single team, such projects are often split into a number of smaller projects, each of which is designed by a different supplier.
But Plant operators do not want to have a different style of operator interface depending on which bit of the plant they are operating. Operational requirement are not the only reason to have a consistency across all the packages. The same applies to hardware, software and documentation.
For example an Engineering Contractor designing a large plant sub contracts the design of one area to one supplier, another area to a second supplier, the utilities to another and the control system to a systems integrator.
So there are several teams in separate locations. In order for this ‘sub-contracting’ approach to be better than the big team system it has to have some advantages. Popular wisdom, and management philosophies both support the increased efficiency of small teams with real control over their tasks.

Responsibilities for the procurement and construction are also distributed, but not necessarily in the same way. For example one control system supplier may be nominated for use by all the process packages as a step in achieving consistency. A process package supplier may not have the required skills to define the phases and this will be delegated to another team.

Ideally the team of teams will have a complete understanding of their zones of responsibility and will thereby avoid the conflicts that can arise when the boundaries of responsibilities are not clear and agreed.

Large distributed projects like these needs careful technical management in order to co-ordinate the various parties. Especially in fast track projects where it has to be right first time.
Standards are required, and these are not yet available for process automation from an ISO numbered document. Those standards, such as S88, that do exist are just guidelines with many opportunities for different interpretation.
All this means that a very active technical management process is required to achieve consistency.

This paper discusses the problems of using conventional ‘last century’ specifications and tools on large projects and explains how ControlDraw can improve the design and documentation process.

Dividing the Tasks

Lets assume that the project has been divided into
Area A – Process Supplier A
Area B – Process Supplier B
Utilities – Process Supplier U
Control System – Control System Supplier
Each has to produce detailed specifications covering their part of the overall application.

Suppliers A,B and U have to provide a detailed functional description of how the equipment that is in their scope is to be controlled. These are to be agreed with the end users and approved by the Design Managers, and then given to Supplier CS.
The Control System Supplier has to provide a system that achieves the required functions.

The Design Manager has the task of co-ordinating all the suppliers, ensuring that each provides the required level of design detail, according to their contracts. And (typically via the CS supplier) of ensuring that all the parts fit together.
This involves an intense process of reading all the documents.

Last century documents – the review problem.

Suppose the various suppliers all work in their 'old' way, providing a mixture of long text documents and disparate spreadsheets and databases, typically based on their last project. It is very hard to read all these documents and there will be technical and style inconsistencies between them making for many problems in reviewing them. The distribution of the ownership of the various parts of a whole control system will increase the problems.
When reading the control requirements text sent by an equipment supplier, is it clear whether it describes something that is really in the scope of the system supplier? (eg, Supplier A says 'If the valve fails to open an alarm is generated and the phase holds'. But the standard system provides valve failure alarms and a command to the standard system provides a hold. And is there a rule that all valve fails in an equipment model cause a hold?)

There is no single search, let alone an intelligent one to help to rapidly review the documents.
And there is no means of measuring the contents of the document. You can count many words. But how many useful words though?
You probably have to painstakingly go through each paragraph and tick off a checklist.
The Control System Supplier will then produce a functional specification that attempts to reconcile all the different suppliers requirements. Often the Control System supplier will take portions of each of the process suppliers specifications into their own specification. This will be yet another document.
You have to review that one too. Another checklist?
It provides plenty of work. And data accuracy, version control problems, and consequent time delays become a major problem.
Many documents include diagrams, for such aspects as control loops, phase logic, graphics, and state transition diagrams
A new version arrives – what has changed?
Suppliers have to change things, as developments and user needs are added into the design. Supplier must carefully document each change, and maintain version control. Word processor compare facilities, whilst very useful, provide a very unstructured way of finding changes, even the issue number of a document is mostly manually maintained. And the compares fail to identify changes within diagrams

Document management systems may help to do that and to ensure that the current version is used, but that is only a thin layer of version control if applied to a collection of dissimilar documents

Data Ownership – and databases

The issues here are concerned with who owns (produces, reviews, approves) each aspect of the overall application. And who supplies the data for each part.
With conventional documents it is possible, but involves a major collation exercise on the part of the implementer, and often the validation teams too.
Most companies use one or more project databases, often linked to their CAD. For example a typical 'instrument IO list' contains the IO addresses, and possibly the instrument scales and ranges. Some contain alarm and trip settings, but only usefully for continuous plants were these are fixed.
But there are may other parameters, such as time setting, physical dimensions, event counts and the parameters that are required by complex control loops, equipment modules and procedural logic.
CAD databases just do not handle these at all. S88 recipe software only really addresses the last of these, and even then is often not appropriate because it is not the sort of software that most suppliers are in the business of using.
Typically suppliers will add a collection of spreadsheets to their deliverables to cover the additional data.
These will cover items such as recipe parameters, and matrix tables for showing equipment states.

Large CAD databases

One approach that has been developed is the large-scale database, that can be distributed to the suppliers. Sometimes this is imposed on the suppliers. The mainstream CAD companies and the engineering IT departments of the major EPC companies have struggled with this for over a decade and have made some major achievements in respect of the physical design of plants, but have never achieved this with the deeper levels of control system functions and their operation.
ControlDraw does not use a large database, it uses MS Access. This is capable of handing up to 10 or so user sessions at the same time, not the hundreds that large EPC companies may have working on a project. However, this is not a problem because ControlDraw is oriented around small teams and has the tools to integrate the work of several teams.

This century documents

- ***An integrated collection stored in a database from each supplier***

Diagrams

Diagrams are used consistently by all vendors

Easy to read.

All the information is presented in concise and clear format, as diagrams, lists, matrices and words as appropriate.

Ownership clear

Each supplier of information is traceable and responsible for maintaining the information as the project develops. At some point it may be handed over, this is also clear and explicitly done.

- ***Fast review***

Model Review system, Search and reporting built-in

The documents can be rapidly searched, including into the details of diagrams.
Original (Read-only) copies of the model can be reviewed and commented on with automated recording of the comments in a database.

Metrics available for all content.

Not just the number of words, but the numbers of each of the objects in the model, measurements that can be used to estimate the next stage of the life cycle and monitor progress and change.

- ***Versions are automatically maintained.***

Version management and recording is built-in

This includes the automatic incrementing of the overall version and the ability to raise Issues of the model to mark project stages. This also includes the archiving of older versions.
In addition there are the means to record within the model additional manual notes on, for example, the reasons for changes.

Detailed object based compare functions

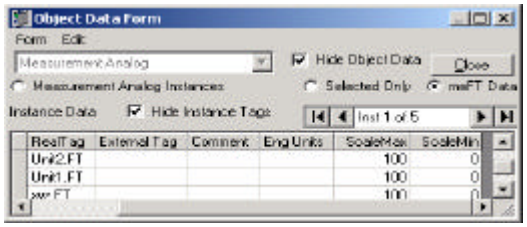
Since everything in the specifications is stored in a single model advanced compare facilities are available. So even if the supplier has not recorded all the changes, it is still possible to fiind them.

It makes the work much easier

ControlDraw

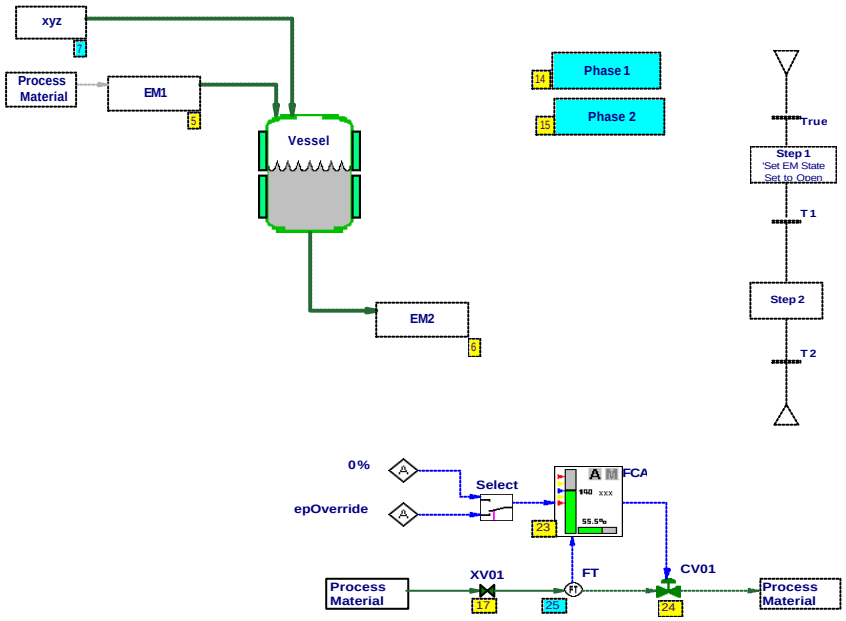
A process control database.

The database covers all the data recording requirements for a process control system specification such as IO Lists, Alarms, equipment parameters and many more.



Process control diagrams

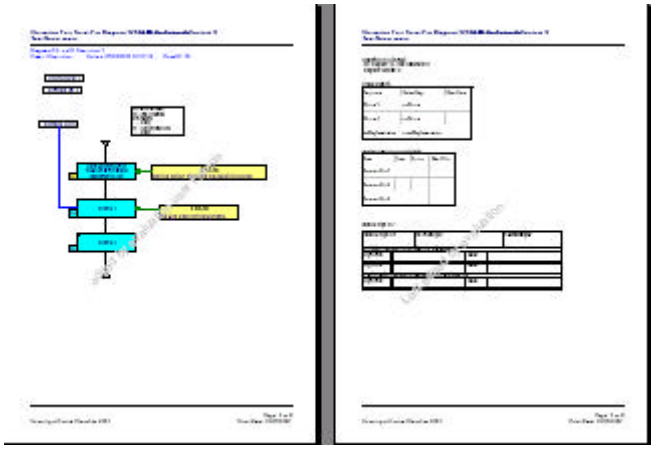
ControlDraw also keeps the diagrams, and matrices in the model.



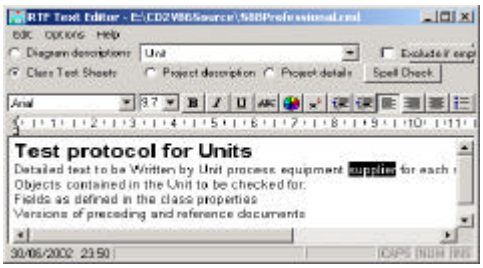
Tools to accelerate review meetings.

Automatic test sheet generation.

One of the biggest and most boring tasks is the production of the test documentation.



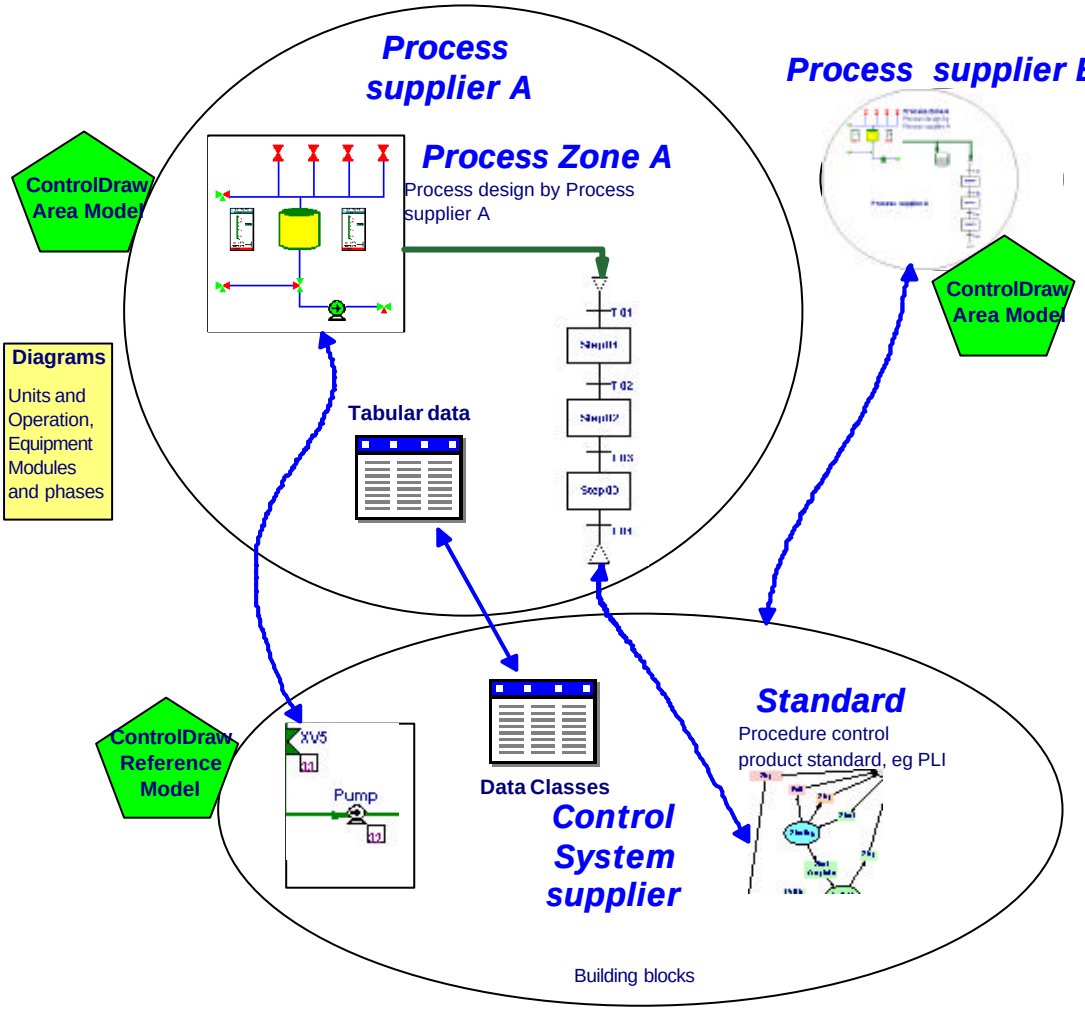
The Words and the test records



The ControlDraw way

Zones of Responsibility captured in models

Each supplier produces a ControlDraw model for their part of the project. The diagram shows simply how it works.



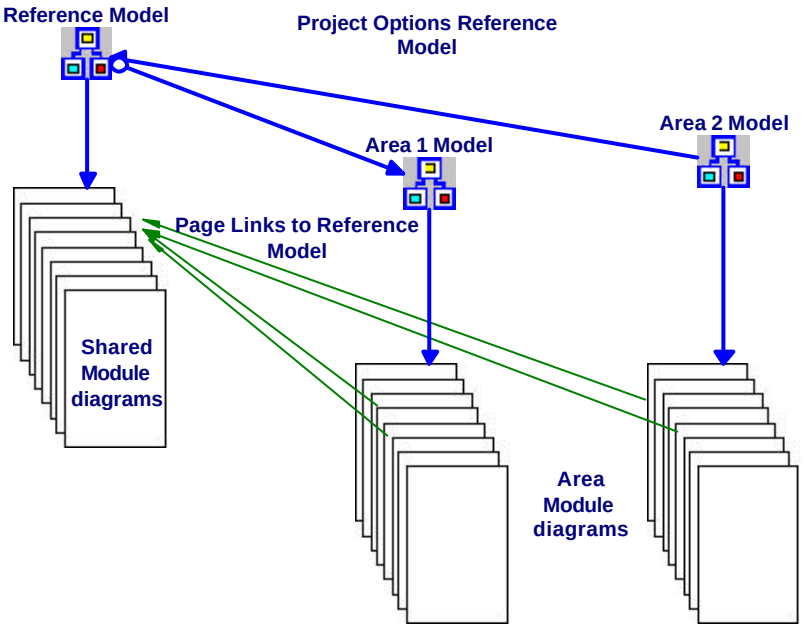
Each supplier has a zone of responsibility, and depends on the other suppliers for the supply of items that are not in their zone. There is nothing special about that, it has been done with physical objects. But it has always been a problem with software.
The PC based ControlDraw Approach combines database and graphics technologies to dramatically improve the process of standardising software objects. And it does by retaining the idea of individuals empowered by PC technology.

Diagrams and data

The approach uses Diagrams, lookup tables such as state matrices, and data tables as appropriate to the type of information being conveyed.
Diagrams in ControlDraw models are more than just pictures:

- The symbols (objects) can be classified, hugely increasing their meaning
- The objects they show can be defined in terms of their dynamic and static properties.
- Object dynamics can be used to animate the diagrams for review and testing.

Data tables for each class define the static properties of the objects
Procedural diagrams can be used to define the required sequential processes
State matrices can used to resolve these into the states of indivdal objects.
ControlDraw provides the means to produce and these in one environment and with the data integrated with the diagrams.
In a large distributed project the issue arises as to how the diagrams and data can be coordinated across multiple models. The following diagram shows simply how the Reference models feature of ControlDraw can be used for this purpose.



Use classes to define who owns the data

All ControlDraw diagrams and the objects on them have a Class. For example, Control Module, Phase etc.
You can use the classes to define who owns (produces, reviews, approves) each diagram and item of data.
To do this you need to define the owner for each class at each design phase.
Each Area suppliers produces a models covering their area. For example the definition diagrams for Units, Equipment modules, operations and phases.
The Control system owner produces the Reference model. This includes the shared objects such as the control modules.
Define the owner for the design of the classes.
Define the owners for the data for each class.
Some data is likely to be known by the supplier, for example the scale and ranges of the instruments that they are providing with their package. This is physical data, equipment parameters.
Some data is likely to be dependent on the recipes that the end user is planning the run. This is true recipe data.

Some depends on the control system, for example I/O addresses.
Some is neglected during the design and only corrected at huge expense during testing and commissioning.
So you can produce a responsibility matrix like the following

Classes	Area Supplier	System Supplier
Control Module	Special ones	*
Control System		*
Effector Analog		*
Equipment Module	*	
Equipment Parameter	*	
Measurement Analog		*
Measurement Switch		*
Motor		*
Operation	*	
Phase	*	Common phases
PID Control Loop	*	
Process Cell	*	
Recipe	*	
Recipe Formula Value	*	
Recipe Procedure	*	
Site		*
Unit	*	
Unit Procedure	*	
Valve		*

How does your existing system compare?

	ControlDraw	MySystem
S88 based structure and database	YES	?
User configurable database	YES	?
Equipment module design tools	YES	?
State matrices	YES	?
State animation and simulation	YES	?
Generic and Instance objects	YES	?
Configurable model structure	YES	?
Multiple model synchronisaton	YES	?
Grafcet / SFC diagrams	YES	?
Logic diagrams	YES	?
Procedure function charts	YES	?
Process mimic diagrams	YES	?
SAMA / Function block diagrams	YES	?
State Transition diagrams	YES	?
Configurable audit trail	YES	?
Auto Version numbering	YES	?
Publish and archiving functions	YES	?
Linked Review comments database	YES	?
Print, PDF and RTF Output	YES	?
Test specification generation	YES	?
Start templates	YES	?