INDUSTRIAL INFLUENCES ON AN ACCELERATOR CONTROL SYSTEM

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Abstract

Industrial applications of a control system package have extended from industrial research to process control. While the requirements of these applications have much in common with accelerator controls, there are always extensions, different emphasises, and additional requirements. These often add to the applicability of the software in all fields and certainly keep the development team challenged. This paper will discuss some of the influences that industrial applications such as power distribution monitoring, casting and rolling mills, and aircraft engine testing have on software originally designed for scientific research. We will also briefly discuss some of the differences in the software development process between development for in–house use and development for sales and industrial use.

History of Vsystem

Vsystem is a commercial control systems toolkit that traces its roots to control systems developed in the Accelerator Technology Division of the Los Alamos National Laboratory. The system was commercialized three years ago by Vista Control Systems, Inc. The software has grown dramatically in those three years in response to the needs of the customer base using Vsystem. The Vsystem toolkit consists of

- Vaccess — A real–time networked database that provides extensive capabilities for monitoring and storing a current view of the system
- Vdraw — A graphical interface builder and viewer for displaying the data in the Vsystem database
- Vscript — A natural language scripting facility with specialized programming knowledge that is based on the client/server model for interacting with the Vsystem database
- Vlogger — A data archiving facility
- Vscan — A utility for scanning hardware and maintaining the view of the system in the Vaccess database
- Valarm — An alarm reporting and monitoring facility
- Vtrend — A new tool for viewing files generated by Vlogger

More complete descriptions of Vsystem may be found in "The Influence of Industrial Applications on a Control System Toolbox"[1].

Recent Status

Applications have been found for Vsystem in an ever growing number of industrial applications, in addition to a large number of accelerators and other large physics research projects such as tokamaks. The new areas of industrial application include industrial power distribution monitoring, industrial process control, aircraft engine testing, FM transmitter monitoring, and toxicology testing. In recent years, the mix of Vsystem sites has been shifting away from an exclusively scientifically oriented customer base to a more even mix of industrial and scientific sites.

Industrial Influences

Ease of Use

In scientific applications such as accelerators, a higher level of computer literacy is assumed and user interfaces can be designed with this in mind. In industrial applications, the user/operator of the control system may have no familiarity with computers. In fact, in some industries, union agreements discourage access to any keyboard for the computer interface. If the union member were required to use a computer keyboard, his grade would have to be changed to a higher level. Also, some industrial applications physically and environmentally preclude the use of keyboards. For an application such as this, Vdraw, the graphical interface builder for Vsystem, was modified so that the complete graphical interface could be used without requiring a keyboard. The primary effect of this requirement was to extend the capabilities of Vsystem menus. Figure 1 shows an example keypad that allows users to enter numerical values and perform other operations by clicking the mouse pointer on the control window.

Control system use by individuals unfamiliar with computers and with little time to learn Vdraw led to the addition of default settings for all of the control tools in Vdraw so that users could build standard looking screens without needing an in–depth knowledge of all of the control

tool options available. This enhancement was a requirement of a client for automobile testing.

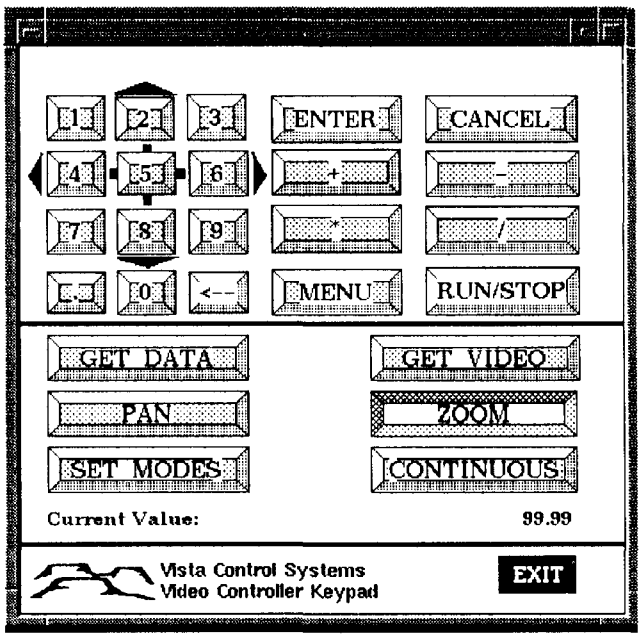

Figure 1. This keypad was modeled after one created by an industrial client who needed keyboard functionality without requiring access to a keyboard.

Visualization

In this important area, industrial applications have had strong impact on the Vsystem control toolkit. To provide the most meaningful information to the engine tester, the bar object of Vdraw was enhanced to have a number of additional attributes that customize the manner and amount of information displayed by the bar object. For another industrial application, the strip chart object was similarly enhanced. One particular enhancement to Vdraw that has direct bearing on most accelerator applications is the addition of an imaging capability to render multivariate data.

Similarly, the alarm management utility, Valarm, has had color customization added to display alarms in user selectable colors so that the colors used can match the corporate error color specifications.

Reliability

While future generations of accelerators will require extremely reliable systems, this requirement is quite common now in industry and has been the driving force behind Vista Control Systems' quality control procedures. In industry, a few hours of downtime for the control system can cost millions of dollars and this cannot be tolerated. The industrial power monitoring system needs reliability on the order of 10^4. This order of reliability will also be needed by the Superconducting Supercollider and other large accelerator projects. Vista has addressed these high reliability requirements by adopting a longer in–house and field test cycle so that a greater percentage of the problems can be detected before the software is released. Also, to adequately track customer difficulties and assure that they are addressed in a timely manner, an internal problem tracking system was developed.

Speed

Industrial process control applications are every bit as demanding of performance as accelerator control systems. Industrial process loops for several industries need to run on millisecond time scales and throughput requirements can be very high with requirements to process hundreds of points at rates up to 100 Hz. Vsystem has been extensively optimized and routines have been added to perform lists of database access, thus greatly reducing the function call overhead.

Industrial applications also require high speed graphics processing. The speed of plotting capabilities have been greatly increased because of the requirements of the engine test facilities. This requirement was handled by adding a fast complement mode to Vdraw's graph control tool that increases the plotting speed by a factor of five. Along with the increased graphics requirements is the need to quickly print the graphically displayed data. This area also has been enhanced in Vsystem as the result of explicit requests from industrial customers.

New Capabilities

The industrial environment has been a fruitful environment for developing requests for new Vsystem toolkit components. The latest component to be added is Vtrend, a history and trending application for viewing the logged data generated by Vlogger. Additionally, there are many other extensions to Vsystem that are on the future development list. Among these are Statistical Process Control and Statistical Quality Control components, interfaces to commercial relational databases, interfaces to industrial analysis packages and more extensive report generation facilities. All of these enhancements to Vsystem are geared toward industry and have little impact on accelerator control systems.

Commercial Versus In–house Development

One of the primary differences between development of a commercial control toolkit versus a control system developed for in–house use is that there are different levels of expectations on reliability. Although this is changing with the ever increasing reliability expected from accelerator control systems for each succeeding generation of accelerators, commercial systems are expected to be error free. In industry, a failure in the control system can cost

many millions of dollars. This translates into extensive internal testing and field testing of a commercial control system. At Vista Control Systems, a substantial fraction of the development process is spent in the test phase.

Another difference between commercial and in–house control systems is that with the commercial systems being used in such a wide variety of industries and applications, consistency between releases *must* be maintained. In an in–house system, the effects of a change in behavior can be estimated because the use of that function is known. In the commercial setting, our experience is that applications and uses will be found for the system that were never anticipated when the control system was first designed. This translates into having many configuration options to maintain old behavior while adding new behavior that may be at odds with the old behavior.

As an example, Vsystem provides an interface to write to the hardware when a channel in the database is changed. Originally, the database value was changed and then the new value was written to the hardware. However, this leaves incorrect data in the database if there is an I/O failure. This prompted Vista to add an option allowing the hardware to be set prior to setting the database value so that failures could be trapped and the database and hardware would always be synchronized.

Interoperability is also a vital component for the commercial market. Commercial systems may have very long lives between system upgrades and different systems must be able to smoothly interoperate. This requirement is still being addressed at Vista. Components of an interoperability strategy are being put in place.

Summary

The experiences of Vista Control Systems, Inc. with Vsystem demonstrate the fruitful interactions that can exist between industrial control applications and control systems designed for use in accelerators and other research applications. The thrust of this paper has been to describe the effects of industrial applications on a control toolkit. It is certainly not meant to imply that there have been a lack of influences from the accelerator and scientific community. The requirements of the two types of applications are not as different as might be expected and both fields contribute ideas and functions that can benefit each other. This synergy between industrial applications and scientific research is a major benefit of a commercial control system toolkit versus in–house development.

References

[1] P. Clout, M. Geib, R. Westervelt, "The Influence of Industrial Applications on a Control System Toolbox", Proceedings of ICALEPCS '92, Tsukuba, Japan, (in press).