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VEE Pro: Practical Graphical Programming

With 294 Figures

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We dedicate this book to our wives:

Sara M. Angus

and

Betty F. Hulbert

who have patiently endured the intensity, time, and effort required to write, test, and publish this book. Without their support, this book could not have been completed.

Preface

This book is written based upon VEE Pro Version 6.2. It contains eighteen lessons and six appendixes. The labs within the lessons introduce ActiveX support, MATLAB® functionality and display capabilities, and support for the new GPIB converters.

VEE Pro Version 6.2 is backwards compatible to at least VEE version 5.01. The labs of all eighteen lessons included in this book have been verified, opened, and run in versions 5.01, 6.01, and 6.2. Programs that work in versions 6 will work similarly in versions 5.

Previous editions of this book have been used successfully with three groups of students applying VEE to laboratory experiments, manufacturing systems, and process-control applications. VEE Pro is popular among technicians, technologists, and design engineers as well as with engineers and scientists. We have prepared this book with the former group in mind.

For those of you who are interested in learning VEE Pro in greater depth than is presented in this book or are designing complex analysis and monitoring systems, there are four excellent books:

- *VEE Pro User's Guide;* Chapter 12 (Platform Specifics and Web Monitoring)
- *VEE Pro User's Guide*; Additional Lab Exercises (Appendix A)
- *VEE Pro Advanced Programming Techniques*
- *Agilent IO Libraries Installation and Configuration Guide for Windows*

Recent improvements from Agilent can be accessed via the www.agilent.com Web site. The latest VEE Pro developments and on-line HELP are included as well.

This book introduces you to the fundamentals of VEE Pro, along with some more complicated examples in the later lessons. VEE Pro has been used to develop and operate programs as sophisticated as:

- At Woods Hole Oceanographic Institute, Agilent VEE programs help researchers to understand the earth's oceans and atmosphere. Research vessels operated by Woods Hole and the submersible Alvin use a common program for data collection, logging, display, and distribution. This program, written in VEE, has been travelling the world collecting data from the wreck of the Titanic, deep-sea hydrothermal vents near the Galapagos Island, has assisted in mapping the Indian Ocean, provided positional data for archeological projects in the Black Sea, and has helped untangle a whale off Provincetown, Mass., U.S.A.
- At the University of California, Berkeley, VEE Pro software has helped speed the design of its entry into the Defense Advanced Research Projects Agency Grand Challenge race of autonomous robotic vehicles. A team of 19 students, with no previous experience in physical test systems, entered the first two-wheel motorcycle into the race. The VEE Pro graphical interface enabled the team to develop test systems, and collect and analyze performance data. A two-wheel (versus four-wheel) vehicle design was chosen because it has a smaller structure, provides increased mobility,

and is less expensive. The challenge is to keep the vehicle upright while it is either stationary or in motion. A control-moment gyroscope was used to stabilize the vehicle; a crossbow solid-state gyro and inertial measurement unit was used to provide the data needed to ensure stabilization at high speeds. See Costlow, 2004.

- In another world, the Mars Exploration Rovers named "Spirit" and "Opportunity" contain a box known as the Small Deep Space Transponder. This box provides a direct link from the Rovers to our Earth. VEE provides the data logging, some automated testing, and command and telemetry interfaces for the testing of these communication links to and from the Earth. Also, the Mars Odyssey orbiter uses these same boxes to relay data to and from the Rovers.

In addition to VEE Pro, Microsoft Excel™ and Microsoft Word™ should be available on your computer. If a database is to be constructed, then Microsoft Access™ should also be installed.

The Agilent Visual Engineering Environment (VEE Pro) is a visual, mostly intuitive, programming language. It dramatically reduces monitoring-and-control software development time. The software programs are developed off-line with virtual equipment and devices. Thus, they do not tie up laboratory, manufacturing, and process-control equipment.

There is a special overview to acquaint supervisors and managers with the capabilities of VEE Pro, along with a related 3.5-inch PC disk of pre-developed labs. Users of this overview learn the capabilities and features without becoming programming experts. They are available at a nominal price by contacting the authors via bobangus@tiac.net.

This book provides the applicable tools for learning VEE Pro so programs can be written for

- data acquisition,
- test-data processing, and
- process control.

The detailed information is provided within the lessons.

Programs are prepared by connecting icons together within VEE Pro and possibly program segments prepared in languages such as C++ and Visual Basic. The resulting program resembles a block diagram that may be run like a program prepared in a textual language such as a "C++" or "Visual Basic". Figure 1 explains how VEE Pro monitors a data acquisition system. Any report generated can be distributed over the Internet.

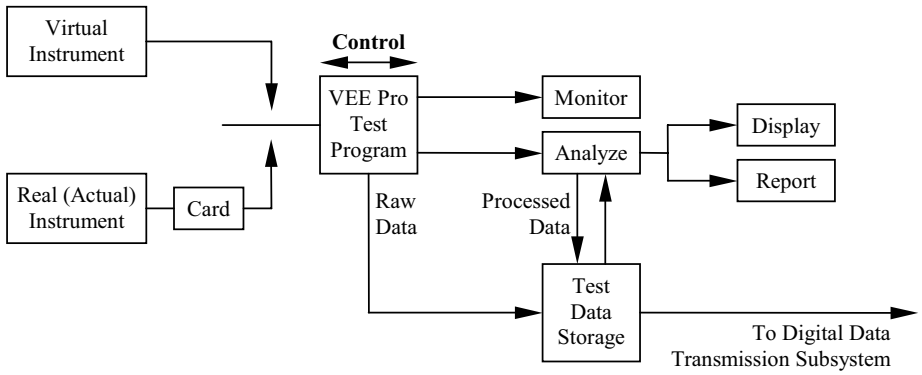

Figure 1. VEE Pro monitoring a data-acquisition system

Virtual instruments exist within the VEE Pro program. Real (actual) instruments can be attached via special plug-in cards. Often, a separate card is required for each instrument. Instruments now coming on-line contain USB links that can go directly to a computer, and some have LAN connections do not need cards.
The VEE Pro test program controls:

- which virtual or actual instrument are connected via VEE Pro,
- what parameters are to be monitored,
- how data are to be processed,
- where data are stored – as either raw data or processed data, and
- how that data are processed for spreadsheets, reports, and databases.

Microsoft Excel™ is used for spreadsheets, Word™ is used for written reports, and Access™ is used for storing large amounts of data in a database. Data can be transmitted to other locations or systems via communications media such as: USB, Fire Wire, LAN, or many of the RS series of protocols. VEE Pro is very powerful and flexible.

VEE Pro is both a language and a graphical development environment. After you have completed each pre-lab and its accompanying labs, you should be able to:

1. visualize the relationship between objects as operational instructions in VEE Pro,
2. identify the VEE Pro Main Window and use its Work Area, Program Explorer, Title Bar Tool Bar, Status Bar and control icons to size, position, monitor and set window operations,
3. use a VEE Pro menu to call a device to the screen,
4. call the Object Menu of VEE Pro objects in two ways, and use the Object Menu to control, view, and set object properties,
5. access and use VEE Pro's Help Menu, and
6. integrate VEE Pro processed data into spreadsheets, reports, and data bases.

Each VEE Pro Object added to the program symbolizes a set of instructions from the VEE Pro library. VEE Pro handles the programming chores and leaves the user free to design and test processes. As the program is being designed, VEE Pro is providing the software. This interactive technique is known as "graphical programming".

The Help menu of VEE Pro can be accessed either from the Menu Bar of any Window or from the Object Menu of any VEE Pro object. The Help Menu provides both a detailed glossary of terms and "How-Do-I" guides to performing an enormous number of tasks within VEE Pro.

All eighteen lessons have laboratories that introduce new objects, concepts, or techniques. In order to enable you to learn the capabilities of the total VEE Pro software package, these items will be presented and illustrated prior to implementing each laboratory. Also, the symbol "◊", when it precedes a laboratory-exercise step, informs you to change parameters so you may expand your understanding of the power and flexibility of VEE Pro.

At the end of the eighteen lessons are six appendixes. These appendixes are designed to guide the casual practitioner to the location of the necessary design material within this book. The following describe each appendix, its contents, and how it can be used:

- Appendix A consists of descriptions of the menu bar and tool bars (buttons or icons). This appendix contains a list of all pull-down menus and buttons for the entire VEE Pro, with shortcut-keys (i.e. Ctrl + …) shown in bold and underlined. The names of the icons on the Tool Bar are also given. This appendix includes an explanation of the mouse operation, how data flows into and out of an object, and the Object order of operation.
- Appendix B is a list of the partial program sequences developed in the lessons. A cross-index of these sequences is provided, arranged alphabetically to allow rapid reference by the program developer.
- Appendix C is a list of the virtual devices and instruments available within VEE Pro. For each of these items, a summary of each applicable Help menu is provided.
- Appendix D contains the definition of the specialized technical terms used in the book.
- Appendix E introduces the objects, icons, and features via a series of seventeen pre-labs.
- Appendix F is a brief summary of the features and functions of VEE 7.0.

Each pre-lab is designed to explain, in great detail, the material which will be first applied in the referenced lesson. If this material were included in the lesson, it would

- detract from the lesson flow and
- be difficult to reference in its entirety by a person devising a new VEE Pro program.

Thus, when going to an example lesson, the person might be confused between the generic material presented in Appendix E and the specific application being developed in the lesson.

Instruction in VEE Pro can be accomplished in at least three different formats.

The Pre-Lab Concept

The first method is to present and discuss the pre-lab in fifteen to thirty minutes, depending upon the depth and number of new concepts introduced. Students then proceed through each lab presented in the lesson by working individually at a station. Each lesson is designed to take the average student about two hours.

The Self-Study Concept

The second approach is to use this book in a self-study, self-paced mode. Students will study the applicable pre-lab material (Appendix E) and, on their own, schedule time on a computer to proceed through each lab.

The Combined Concept

The last method combines the previous two above. The pre-lab is presented to an entire class, and the labs are completed by individual students at their own pace. The only constraint is that the previous lesson must be completed before the next pre-lab is presented.

The eighteen lessons gradually present how to learn VEE Pro by focusing upon the graphical general and specialized icons available within VEE Pro. These icons can be combined and attached to virtual or real instruments via an Instrument Manager. Data analysis can be performed by a combination of built-in mathematical and statistical calculations located in the Function & Object Browser and the specialized MATLAB® script.

Demonstration of the power and flexibility of VEE Pro is presented via a virtual Vehicle Radiator. It starts with the simple monitoring of a simulated temperature and ends with monitoring and logging the Vehicle Radiator temperature variations using the VEE Pro Sequencer. Special labs include:

- Simulating a thermometer and monitoring that temperature
- Calculating, logging, and displaying temperature and pressure statistics
- Building databases and spreadsheets
- Writing reports that summarize and display that data
- Plotting temperature variations via MATLAB®
- Monitoring and logging test limits containing audio and visual warnings

When this book is used by instructors at an educational or training institution, various combinations of the above can be devised to comply with their class and laboratory scheduling requirements.

The appendixes are devised to support the reader – both during the learning of VEE Pro and when this book is used as a reference at a later time. The appendixes are:

- Appendix A – Menus, Buttons, the Mouse, and Data Flow – detailed descriptions of the menu bar, tool bar, pull-down menus and buttons, mouse operation, how data flows into and out of an object, and the Object's order of operation
- Appendix B – Partial Programming Sequences – a cross index of partial program headings
- Appendix C – Virtual Devices and Instruments – a summary of each available within VEE Pro
- Appendix D – Definition of Technical Terms – devised especially for those whose technical vocabulary includes very little related to programming
- Appendix E – Introducing Objects, Icons, and Features – seventeen pre-labs that explains them in more detail than is given within the individual labs
- Appendix F – Agilent VEE 7.0 Features – the forthcoming capabilities of the new version are described with information that will lead the reader to additional information

The Bibliography contains a list of reference manuals, technical papers, articles, and textbooks related to VEE Pro.

Exchange of information among the user community is supported via an interactive Agilent Web site (vrf). The address is www.agilent.com/find/vrf and it is available 24 hours a day, seven days a week. All users are encouraged to register and use this Web site to gain additional knowledge, insight, and information. This will help you to keep informed of any changes that the Agilent designers might propagate via this Web site.

The authors believe that the most powerful feature of this book with its appendixes is its value as a reference during the design process, the running of real manufacturing processes, and the design-and-analysis of laboratory experiments.

Robert Angus
Thomas Hulbert

English may be a difficult or second language for you.
The words in this book have been carefully chosen to ease the reading.

Acknowledgements

The material in this book was prepared from the following sources:

1. *Visual Programming with HP VEE* by Robert Helsel
2. *Introduction to VEE Pro E212E+24D Student Manual* by the Hewlett-Packard Test & Measurement Education Services
3. *VEE Pro Advanced Programming Techniques* by the Agilent Technologies staff
4. *VEE Pro User's Guide*, by the Agilent Technologies staff
5. *Installation and Configuration Guide for Windows*, by the Agilent Technologies staff

We are indebted to the authors of and contributors to these books.

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Without their encouragement and critiques, this book could not have been written and tested.

To the Instructor

The Agilent Visual Engineering Environment (VEE Pro) is a visual, mostly intuitive, programming language. It dramatically reduces monitoring-and-control software development time. The software programs are developed off-line with virtual equipment and devices. Thus, they do not tie up laboratory, manufacturing, and process-control equipment.

VEE Pro is very powerful and flexible. It is designed to operate in a Windows environment. Microsoft Excel™ and Word™ should be available on your computer. If a database is to be constructed, then Access™ should also be available.

Instruction in VEE Pro can be accomplished in at least three different formats.

- The first method is to present and discuss the pre-lab in fifteen to thirty minutes, depending upon the depth and number of new concepts introduced. Students then proceed through each lab presented in the lesson by working individually at a station. Each lesson is designed to take the average student about two hours.
- The second approach is to use this book in a self-study, self-paced mode. Students will study the applicable pre-lab material (Appendix E) and, on their own, schedule time on a computer to proceed through each lab.
- The last method combines the previous two above. The pre-lab is presented to an entire class. Each lab is completed with no individual time constraints. The only requirement is that the previous lesson must be completed before the next pre-lab is presented.

When this book is used in a more formal way at your educational or training institution, a combination of the above can be devised to comply with your class and laboratory schedule.

Much success has been achieved by assigning projects to groups of up to three students once they reach Lesson 5. Students usually choose real problems either from their academic or work environment or from local industry. In the last class, these students present their problems along with their solutions.

The most powerful feature of this book with its appendixes is its value as a reference.

- Appendix A describes the VEE Pro program menus, buttons, the mouse, and data flow.
- Appendix B is a cross-index of partial program sequences.
- Appendix C is a list of the virtual devices and instruments available within VEE Pro.
- Appendix D contains the definition of the specialized technical terms used in the book.
- Appendix E introduces the objects, icons, and features via a series of seventeen pre-labs.
- Appendix F is a list of the features of Agilent VEE 7.0 as envisioned by the developers.

Recent improvements and upgrades from Agilent can be accessed via the www.agilent.com Web site. The latest VEE Pro developments and on-line HELP are included as well. For qualified academic institutions, a multiple-seat license with full documentation is available at a substantially discounted price. Contact Agilent via its Web site (above).

To the Student

This book has been prepared to be a study guide and reference for technical personnel responsible for designing complex test, measurement, and data-acquisition systems, and collecting and analyzing laboratory-test data. You will learn to program via a visual engineering environment (VEE). This present version is known as VEE Pro.

Portions of each program are contained in code represented by Objects and icons. Each VEE Pro Object added to the program represents a set of instructions taken from the VEE Pro internal library. Each time a new Object is added and interconnected with the others, the computer's program prepares and links additional instructions in VEE Pro. The capabilities of your program are being devised.

VEE Pro simplifies the programming chores and leaves the user free to design and test processes. As the program is being designed, VEE Pro provides the software. This interactive technique is known as "graphical programming".

Most of the eighteen lessons have laboratories that introduce new objects, concepts, or techniques. In order to enable you to learn the capabilities of the total VEE Pro software package, these items will be presented and illustrated prior to implementing each laboratory. At the end of the eighteen lessons are six appendixes. These appendixes are designed to guide the casual or experienced practitioner to the location of the necessary design material within this book. The following describes each appendix:

- Appendix A – the VEE Pro program, when opened, consists of a menu bar and a tool bar (buttons or icons). This appendix is a list of all pull-down menus and buttons for the entire VEE Pro, with shortcut-keys (i.e. Ctrl + …) shown in bold and underlined. The names of the icons on the Tool Bar are also given. The mouse operation is explained in detail. It is followed by how data flows into and out of an object and the Object order of operation.
- Appendix B is a list of the partial program sequences developed in the lessons. A cross-index of these sequences is provided, arranged alphabetically to allow rapid reference by the program developer.
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- Appendix F is a list of the features of Agilent VEE 7.0 as envisioned by the developers.

We wish you well in the pursuit of your educational and vocational goals and the application of VEE Pro to the solution of your technical and design problems.

Table of Contents