

A Complete Software Engineering Environment

New views of mature ideas on software and quality productivity.

A COMPLETE SOFTWARE ENGINEERING environment is comprised of all the engineering tasks for developing, reengineering, and maintaining software systems. These tasks can be supported by automated tools, manual procedures, or both. The organizational challenge is to automate the right tasks in the correct order so that they have the greatest impact on software quality and engineer productivity. Our experience indicates that tools for managing system requirements, configurations and changes, acceptance testing, and verification and validation result in significant, measurable benefits. Throughout 1997, Toolbox will examine the tools for requirements management, verification and validation, and transition management. This month's column sets the context for describing these tools and their interfaces to other tasks, whether automated or manual.

Most organizations already have these components in some form. Manual techniques provide legitimate alternatives to automation, so you should consider them when assessing a software engineering environment. What most tool environments lack is integration of individual tools and integration and coordination of the tools with project team members.

EVALUATION TIPS. When evaluating a tool, consider the new tool's effect on current manual techniques and existing tools—the integration of the tools into the organization. The toolsets organized along traditional job functions will, at least initially, create less user resistance. Software professionals want tools that will help them do what they're already doing better, not tools that will force them to do their jobs differently. Once the first wave of technology is assimilated, the inherent characteristics of the technology will increasingly influence the process. Improving software quality and developer productivity starts with specific quality and productivity objectives and with an assessment of the software engineering process relative to those objectives. You then choose tools that complement your engineering process and contribute to fulfilling your objectives.

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Industry experience with system development and redevelopment has shown that no single tool can effectively improve the entire development process. Although individual tools can increase productivity by 10 to 15 percent, the unautomated portions of the development process become critical bottlenecks that constrain overall gains. In addition, many studies have shown that main-

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tenance efforts can account for 50 to 80 percent of a software product's cost over its lifetime. Consequently, you will realize the greatest leverage when your entire software development and maintenance process is fully automated in a seamless environment.

COMPONENT SPECTRUM. A complete environment comprises a carefully configured and integrated system of automated tools applied to the entire software life cycle for each unique software development, maintenance, or redevelopment problem. Figure 1 shows components of such an environment, which can be categorized as follows.

Development. This category consists of the automated tools, management procedures, and practices for designing, developing, and implementing software. These tools are typically used by systems analysts, programmers, and software engineers to develop new and replacement software.

◆ *Front-end tools.* These tools address systems planning, requirements definition, high- and low-level design, and system prototyping and simula-

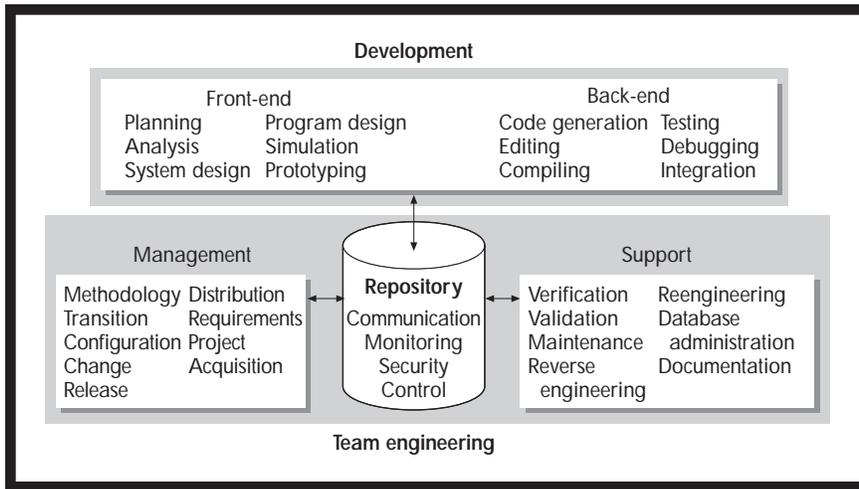


Figure 1. The components of a complete software engineering environment. The arrows represent the import/export interface.

tion. Most front-end development tools combine textual and graphical specification languages such as structured analysis and design, object-oriented analysis and design, and data modeling. These tools also provide automatic checking for adherence to design rules.

◆ *Import/export interface.* This automated tool or utility extracts data from and inputs data into a vendor's repository. The arrows in Figure 1 represent this tool.

◆ *Back-end tools.* In contrast to front-end tools, these tools target software code and application generation, editing, compiling, debugging, verification, performance analysis, and hardware integration testing.

Management. This category includes management processes, procedures, and practices—usually supported by automated tools—for planning, controlling, and monitoring a software project.

◆ *Methodology/process management.* This well-defined process provides for controlled and orderly system maintenance, development, and/or reengineering that meets specified budget and schedule constraints.

◆ *Transition management.* This formal process moves data from one information system's architecture to another by managing the deployment of new system components that must be synchronized

with existing system components.

◆ *Configuration management.* This process manages—often with the aid of automated tools—the set of related modules that constitute a complete software system. You typically do configuration control at the file level, as a counterpart to change control. The process also enforces change authorization and check-in/check-out procedures. In addition, a configuration control system often automates the conversion of the set of modules into one linked executable image (the "Build" process) and maintains the list of included modules and parameters relevant to the configuration process. More advanced configuration management systems include requirements analysis models, designs, test cases and test scenarios, user and system documentation, and the code modules.

◆ *Change control.* A subset of configuration management, this process manages changes in design documents, source codes, test plans, and other documentation entities from one software version to the next. A change control system defines a check-in/check-out process for approved software modules and limits authorization to make changes to the "official" code. The system also provides an archive mechanism for retrieving previous versions of documentation and maintains the relationships between enti-

ties so developers can determine the impact of a proposed change.

◆ *Release and distribution management.* An extension of the build process, this process distributes new software releases over the network for installation. Each release may require special instructions and installation utilities. The process may vary depending on if the release affects server or client applications.

◆ *Requirements management.* This process provides a rigorous method for establishing, maintaining, and reporting the correspondence between a system's requirement specification and the system's architecture, design components, modules, interfaces, test approaches, and test data throughout the software life cycle. The process includes reports showing how a software system meets the requirements, sometimes called a requirements compliance matrix. When tied to requirements tracking, compliance reporting can show where in the design and the source code a requirement is satisfied.

◆ *Project management.* This process plans, budgets, estimates, tracks, and allocates resources to a software project. Tools to meet these goals should be tied closely to process and configuration management for determining change impacts.

◆ *Acquisition management.* This formal process selects, manages, evaluates, and accepts software purchased from an outside vendor. It is usually part of an overall software methodology used when the software will not be developed by the in-house staff.

Support. This category of tools and procedures supports, maintains, and enhances existing software systems.

◆ *Verification and validation.* These tools perform two functions. First, they help you determine whether or not the products of a given phase of the software development cycle fulfill the requirements established during the previous phase. Second, they review, inspect, test, audit, or otherwise establish and document whether or not items, processes, services, or documents conform to specified requirements.

◆ *Maintenance, reverse engineering, and reengineering.* These tools simplify the maintenance process, improve understanding of existing systems, and improve the accuracy and facilitate the verification of changing software systems. Do not confuse them with back-end tools used for debugging and testing software changes.

◆ *Database administration.* These tools and procedures establish and maintain the data definitions, data relationships, database descriptions, and storage and retrieval requirements for the database in each software system under development or in maintenance.

◆ *Documentation control.* This procedure maintains configurations and versions for all software system documentation at a particular installation. It involves database administration, requirements tracking, configuration control, and change control.

Repository. This category includes the components that form the database that

contains information relevant to system design, implementation, and maintenance. These components include design representations and rules, source code, documentation, and management information. Ideally, the project database will accommodate all projects at an installation; at the least it should provide the documentation control, interteam communications, security mechanisms, and management control for each software project. The project database is part of an integrated project support environment that provides a uniform method for invoking a variety of individual tools and handling the data transfer among them.

Team engineering. The tools in this category, facilitated by the repository, provide communications and data sharing between developers, managers, and support personnel.

SYNERGY ENABLED. It is unlikely that any one vendor will provide the tools to

assemble this entire redevelopment environment anytime soon. Instead, tool vendors will specialize in some tool classes and cooperate through formal and informal partnerships to provide tool compatibility. Most vendors live within their resource constraints by attacking only a segment of the complete environment. In this way a vendor can provide a focused solution to a major subset of a user's overall software redevelopment needs, complementing offerings from other vendors in a synergistic manner.

The ideal environment has multiple dimensions made up of a cohesive module set for analysis and design, requirements tracing, coding, simulation, testing, reverse engineering, formal documentation, configuration management, project management, and process management. Tools targeted for large software projects must also facilitate communication and coordination among numerous team members and maintain configuration control of program modules. ◆

top drawer

◆ **Java client generator.** Magna Software's Magna X 2.4 Network TP application generator creates transaction processing systems for intranets and the Internet. The latest release adds Java client generation to the product's existing PowerBuilder and Visual Basic client generation capabilities. Java connectivity can be accomplished with advanced transaction processing monitors such as IBM's CICS/6000 or Transarc's Encina. Magna X also provides midrange services and CICS mainframe services. The product can help COBOL program-

mers link their applications to a Java front end by supplying Java classes and methods to bridge datatype and other language differences behind the scenes. Pricing for Magna X 4.2 starts at \$62,000 for a five-seat license. The product is available for the CICS/6000 and the Encina DE-Light Gateway. Contact Magna at 212-691-0300, fax 212-691-1968; glong@magna.com.

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◆ **Repository-based development tool.** Genitor Corporation's Genitor is a C/C++ development tool that offers the combined

benefits of a graphical editing environment and a shared object repository. Genitor lets programmers construct any kind of C or C++ object—including classes, functions, groups, unions, or templates—and store it in one or more sharable databases. The product automatically generates compiler-ready code in a variety of formats. Genitor can also be used to generate online or printed documentation that describes an object or collection of objects. The product supports administrative tasks by integrating with several version control sys-

tems, compiler IDEs, program editors, testing tools, word processors, and help compilers. It also provides DDE and command-line access to key functions, which lets developers add Genitor operations to menus and toolbars in other applications. Genitor, available in single-user and multi-user configurations, runs on Windows 95 and Windows NT 4.0. Pricing starts at \$495. Contact Genitor at 1-888-436-4867 or 313-213-2500; fax 313-213-2525; info@genitor.com.

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◆ **Reengineering toolkit.**

ICL's Dialogue Manager 4.1 is a legacy and reengineering toolkit that lets developers provide users with single-screen access via an Internet browser interface to data held on many different legacy systems. Standard Windows environments are also supported. Dialogue Manager uses an object-oriented approach and reusability to simplify client design and let organizations accommodate business process changes at users' PCs without making changes to existing back-end systems. Version 4.1 adds support for Internet-browser client development, 32-bit operating systems, and an extended set of third-party terminal emulation and application-development software packages. Supported legacy applications include those running on IBM, DEC, Unix, and other hosts that support IBM 3270 or DEC VT terminal emulation. Dialogue Manager support includes C, C++, Micro Focus COBOL and HTML, and x/Open's Application to Transaction Monitor Interface. Dialogue Manager requires at least a 486-class processor running Windows 3.x, Windows 95, or Windows NT; 4 Mbytes of RAM are required for runtime operation and 8 Mbytes for development work. The Dialogue Manager development package costs \$5,995; runtime prices range from \$100 to \$295 per user. Contact ICL at 703-648-3300, fax 703-648-3350; <http://www.icl.com/DialogueManager>.

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◆ **Visual modeling tool.**

Rational Software's Rational

Rose version 4.0 provides a visual modeling solution that extends from capturing business requirements through analysis and design to construction. Version 4.0 has full support for the industry-standard Unified Modeling Language, including use cases for defining user requirements. It also offers an open application interface for integration with third-party tools. Rational Rose can help teams implementing iterative processes to maintain consistency by using round-trip engineering—the ability to generate source code from the system's visual model, to edit the source code, then to reverse-engineer the changed source code to update the design and to see new design changes. The product provides this support for Ada, C++, Forté, Java, PowerBuilder, Smalltalk, Visual Basic, and others. A new, open, and extensible scripting language lets developers create Wizards and produce customized reports. A published API allows integration with the developers' own tools and processes. The product is both an OLE Automation Server and a Controller. Rational Rose scales from small to large projects and supports geographically distributed development teams across multiple platforms. Rational Rose for Windows costs \$2,400. Available for major Unix platforms, including SPARC, HP, Digital, IBM, and SGI, the product's cost ranges from \$6,000 to \$8,400. A free demo copy is available at <http://www.rational.com/rose> 4. Contact Rational at 1-408-496-3600, fax 1-408-496-3636; karam@rational.com.

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◆ **Mac embedded apps**

toolset. MetaWare's High C/C++ Embedded PowerPC Development Toolset lets developers create embedded applications for the 400, 500, 600, and 800 series of PowerPC processors. Hosted on PC and Unix platforms, Version 3.5 of the product provides developers with a range of features and enhancements, including branch-prediction optimizations, which allow program behavior feedback. This feedback can improve code generation quality in subsequent compilations, resulting in performance gains of up to 10 percent. Other features include a branch profile lister that tracks how often a source line was executed and the execution time corresponding to each function; software pipelining, which determines dependent instructions in a loop and places them into a temporal pipeline that can make more efficient use of the instruction cache; and millicodes to save and restore nonvolatile registers, which can reduce code size.

Single-user license fees for the High C/C++ Embedded PowerPC Development Toolset start at \$2,195. Contact MetaWare at 408-429-6382; fax 408-429-9273; techsales@metaware.com; <http://www.metaware.com>.

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◆ **Intelligent agent.** Open Sesame's Learn Sesame Toolkit is a development system for Windows NT and SGI Unix that provides intelligent-agent learning technology components for Web site, backoffice, desktop, and telephony applications. The product can learn

and anticipate each user's preferences. Over time, the toolkit learns what users like based on their direct feedback and their inputs to the application. The more a user interacts with an application, the more data the toolkit acquires to customize the application to the user's needs. The toolkit also gives the application using it the ability to autonomously monitor user actions and personalize the application. It can also suggest automation routines for repetitive user tasks, then implement them with the user's approval. Learn Sesame works with both Netscape Navigator and Microsoft Internet Explorer browsers and can be implemented with Java, Cold Fusion, and LiveWire applications. The product is C++ compatible and supports rule-base-level and code-level integration. Limited licensing for the Learn Sesame Toolkit starts at \$45,000. Contact Open Sesame/Charles River Analytics at 617-491-3474, fax 617-868-0780; info@opensesame.com; <http://www.opensesame.com>.

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◆ **Netscape plug-in creator.** Desiderata Software's PluginMaker creates new plug-ins for Netscape Navigator and can also provide a web interface for existing C++ or C code by turning them into plug-ins. PluginMaker creates files that aid in debugging, testing, and processing data. Users can process data a line at a time, in fixed-size blocks, raw as it arrives from Navigator, or download it to a file. Java and Javascript interfaces are available, using

LiveConnect with Netscape Navigator version 3.0 or later. A plug-in installer is included with the product. PluginMaker installs an AppWizard so that developers can create plug-ins directly from Visual C++, by creating a new project workspace and selecting the PluginMaker AppWizard. Alternatively, the familiar document/view model can be used for creating the plug-in. Dialog-based plug-ins can be created as well, allowing use of various Windows controls. PluginMaker lets developers create more than one instance of the same plug-in on the same web page and includes a program to create self-extracting installers for the plug-ins. PluginMaker requires Visual C++ version 4.0 or later and costs \$295 per royalty-free copy. Contact Desiderata Software at 800-494-8334 or 617-292-5250; plugin@desisoft.com; <http://www.desisoft.com>.

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◆ **Productivity and measurement system.** Union Pacific Technologies' PQMPlus Release 2.0 is an application development productivity and quality measurement system. The system supports project estimating, scheduling, risk and corporate value assessments, and productivity analysis. It maps the complete software life cycle upfront and offers a standard approach for managing application development through the use of consistent assessment techniques resident in the software. PQMPlus modules, which can be purchased separately,

include Manager, an integrated repository that lets project managers determine the causes of budget overruns; Analyst, which supports function point analysis and application sizing independent of operating environment; and Planner, which gives a bottom-up view of all project components and provides what-if analysis and risk-adjusted estimates. PQMPlus interfaces with major project management systems such as Microsoft Project. It runs on Windows 3.x, Windows 95, Windows NT, and WIN OS/2. A single copy of the complete PQMPlus system costs \$5,900; individual modules cost \$2,000 each. Contact Union Pacific Technologies at 314-768-6800 or 800-877-0328; <http://www.up.com/upt>.

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◆ **Real-time graphics package.** DataViews' DV-Xpresso 2.0 is a real-time graphics package that lets developers create and customize cross-platform 2D and 3D dynamic data displays for decision support and can help users make rapid decisions based on time-sensitive data. Dynamic graphics built with DV-Xpresso can be deployed to the Web, Windows, or Unix and retain the native look and feel of each platform. The product can also be used to control, monitor, and represent data for executive information systems in industrial and financial applications. DV-Xpresso includes more than 120 standard charts and graphics that give developers a resource-based graphics

model with drill-down functionality. By supporting both real-time data sources and relational databases, the product provides users with visual representations of dynamic data. The product's Application Builder has a point-and-click editor that lets developers create custom decision support graphics. Its Web-Xpresso component supports Netscape's LiveConnect and lets Web users access real-time or historical data from the server or client side via either third-party access tools or a programmed connection using the Common Gateway Interface script, C, C++, Java, or Javascript. DV-Xpresso supports 3D animation, a C/C++ interface, Microsoft Visual Basic, an object-oriented architecture, and a multiple document interface that lets users edit multiple drawings in multiple windows. DV-Xpresso pricing starts at \$1,000. It is available for Windows NT, Windows 95, and several versions of Unix. Contact DataViews at 413-586-4144 or 800-732-3200, fax 413-586-3805; info@dvcorp.com; <http://www.dvcorp.com>.

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◆ **Mac and PC encryption utility.** Azalea Software's carrick 1.1 is a private-key encryption utility based on the Blowfish encryption algorithm. The product allows keys up to 448-bits long and cannot be sold outside the U.S. It includes an application program interface that lets developers integrate carrick into their own applications. With a DLL at its core, the API can be called from within word

processors, spreadsheets, and databases, as well as applications written in Visual Basic or C/C++.

The carrick encryption utility is available for the Macintosh and for Windows 3.x, Windows 95, and Windows NT. It costs \$159. Contact Azalea at 1-800-362-7978, fax 1-206-937-5919; carrick448@aol.com.

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◆ **Visual Basic DLL Compiler.** PowerBasic's PowerBasic DLL Compiler version 1.5 is a dynamic link library compiler for Visual Basic. Features new to version 1.5 include 32-bit support for the built-in assembler, huge pointer indexes, two-dimensional index pointers, and language extensions like MessageBox, Open Handle, and Input-Box. The new version needs no external libraries and can generate DLLs as small as 4 Kbytes. The Direct/32 package, also included with the product, lets developers create a single 16-bit DLL that can be used with both 16- and 32-bit applications in Windows 3.1 and Windows 95. The 16-bit DLL also lets programmers perform tasks unavailable in 32-bit code, such as direct access to hardware ports and shared memory. According to PowerBasic, the 16-bit DLL accelerates compile times and can compile native code at speeds in excess of 700,000 lines per minute on a fast Pentium. The PowerBasic DLL Compiler costs \$149; users of previous versions can upgrade to version 1.5 for \$25. Contact PowerBasic at 800-780-7707 or 408-659-8000, fax 408-659-8008.

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