

# Best practices for implementing automated functional testing solutions

White paper



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**Abstract:** Today's enterprises need to conduct thorough functional testing of their mission-critical applications to verify that all business processes work as expected. By implementing automated functional testing, your company can dramatically increase both the speed and accuracy of your testing processes, providing a higher return on investment (ROI) from software projects while dramatically cutting risk.

This paper presents a brief overview of the advantages and challenges of automating functional testing to help structure your thinking about how best to approach test automation. It also summarizes the key features and benefits of HP's automated functional testing software—HP QuickTest Professional software and HP Service Test software—some of the industry's most popular and powerful automated software testing solutions. The paper concludes with a brief overview of HP Business Process Testing software and presents a checklist of the five keys to successful automated testing.

## Introduction

There is no question that rigorous functional testing is critical to successful application development. The challenge for your developers, QA teams, and management alike is how to speed up testing processes and increase accuracy and completeness—without breaking your already tight budgets.

By automating key elements of functional testing, your company can meet aggressive release schedules, test more thoroughly and reliably, verify that business processes function correctly, and ultimately generate higher revenue and customer satisfaction from your online operations.

Yet the prospect of automating functional testing raises new concerns:

- What are the costs of automating the testing processes and what is the ROI?
- Which applications/processes are candidates for automated testing and which are not?
- Will new training be required and how will that impact current development project schedules?
- What is the proper methodology for automating a testing effort?
- What is involved in maintaining automated tests?
- When comparing test automation products, which features are most important?

These and other issues need to be fully examined and understood before test automation projects are initiated.

## Functional testing vs. unit testing

Functional testing provides the ability to verify that applications work as they should—that they do what users expect them to do. Functional tests capture user requirements in a useful way, give both users and developers confidence that the business processes meet those requirements, and enable QA teams to verify that the software is ready for release.

Functional testing is complementary to—but quite different from—unit testing. Simply put, unit tests indicate whether the code is doing things right; functional tests tell whether the completed application is working correctly and providing the proper functionality. Unit tests are written from the code developer's perspective, while functional tests are written from the end user's and business-process perspective.

**Figure 1: Application testing today**  
More permutations result from higher infrastructure complexity.

Severity	Total number	Examples
Platforms	1	Intel®
Operating systems	5	Windows® XP, ME, 2000, NT®4, and Vista®
Front-end clients	4	Internet Explorer 6, Netscape 7.1, Java™, Visual C++
Business processes	5	Login, search, order entry, order confirmation, order fulfillment
Data sets	15	Combinations of usernames, passwords, search strings, order numbers, ship dates, etc.
Total tests to run	1 x 5 x 4 x 15	+ 1,500 possible test scenarios!

## Why automate functional testing processes?

The pressure on today's IT organizations continues to build. Management is looking to IT to deliver new capabilities, unlock new business opportunities, and deliver competitive advantages through software. This means the addition of many more business application development projects with tighter deadlines—but not always with more budget or incremental resources.

At the same time, management is becoming increasingly aware of the critical links between software and revenue. Web services, online transaction processing (OLTP), and enterprise resource planning (ERP) applications are not only mission-critical, they're directly tied to your company's ability to generate revenue.

Today's enterprises rely on very complex computing infrastructures. As shown in Figure 1, a typical organization may depend on multiple applications that were built to work on different operating systems, use several different front-end clients, involve numerous business processes, and interact with many separate data sets. Testing all possible permutations of these components creates a highly complex testing situation with hundreds or thousands of testing scenarios.

When software fails, the expense can be extremely high—from lost sales to unproductive employees to unhappy customers and demoralized development and QA teams. The later in the development cycle defects are found, the more expensive they are. A defect identified in a production environment can be greater than 100 times more expensive to fix than the same defect identified earlier in the design phase.

Automation is key to improving the speed, accuracy, and flexibility of the software testing process, enabling your company to find and fix more defects earlier.

## The benefits of automated functional testing

The benefits of functional test automation are many and include the following:

- **Reduce risk.** By providing more comprehensive testing coverage, automated functional testing reduces the risk of production failures and increases ROI.
- **Enable faster execution.** Computers are orders of magnitude faster than humans at executing functional test scripts, so more tests can be done in less time, more applications can be tested in a given period, and more projects can be delivered on schedule. And unlike humans, computers work 24 hours a day, including nights, weekends, and holidays; they don't get bored or tired; and they don't make assumptions about what works and what doesn't. Here, ROI can be measured in terms of time and man-days.
- **Facilitate greater test coverage.** Automated functional testing products support the execution of test scripts across all popular browsers, operating systems, etc. Regression testing of ever-changing applications and environments with automated tools is easier than with manual processes. And with integrated data-driven spreadsheet capabilities, test automation products allow your developers and QA teams to perform calculations, manipulate data sets, and quickly create multiple test iterations to expand test case coverage. With automated testing tools, any mix of transactions and any user workload can be quickly emulated.

- **Deliver higher test accuracy and find more defects earlier.** Test automation gives your developers an easier way to replicate and document software defects, helping expedite development processes while verifying correct functionality across all environments, data sets, and business processes.
- **Provide formalized processes.** The introduction of automated testing encourages your test teams to formalize their processes, resulting in higher test consistency and better documentation records.
- **Facilitate the re-use of tests.** Once tests are scripted, your developers can use, re-use, and add to the test suite as they make changes to their applications. There is no need to re-create scripts to test the same functionality for each application modification.
- **Support ERP/CRM implementations.** As more companies are implementing ERP/CRM solutions, the need to do end-to-end regression testing is becoming more frequent and more crucial.

## How to identify candidates for automated testing

In general, it makes sense to focus automation efforts on critical business processes, complex applications, and the use cases that comprise them (as opposed to lower-level tasks, such as system-level verifications). But if your enterprise has multiple software testers spending many hours per day and still has quality and functional problems, you could definitely benefit from moving to automated testing.

The decision of whether or not to automate the test process should be driven by ROI considerations. In general, there will be a positive return if the application requires regression testing, requires

multiple builds/patches/fixes, needs to be tested on numerous hardware or software configurations, and supports many concurrent users. In addition, if repetitive tasks such as data loading and system configuration are involved, or if the application needs to meet a specific service-level agreement (SLA), automation will certainly make economic sense. Automation does not make sense when testing the usability of a user interface (UI) or for exploratory testing or applications that are not yet mature.

## How to determine the ROI of automated testing

The ROI for any investment can be obtained from a simple calculation:

$$\text{ROI} = \frac{\text{Net present value of the investment}}{\text{Total initial cost}}$$

When it comes to automating functional testing processes, the costs are tangible but the net present value also includes many intangible factors. The best approach is to determine with as much precision as possible what the hard-dollar costs are and then compare them to the hard- and soft-dollar benefits of automating the test efforts.

Hard-dollar costs to consider in an ROI calculation include:

- **Acquisition costs**—the cost of initially acquiring the test automation software.
- **Hardware costs**—the cost of the hardware required for functional testing. Typically, no special-purpose hardware is needed for functional testing, provided the tester has access to a standard desktop computer or workstation with an Ethernet port.

- **Labor costs**—factor in the cost of trained personnel to script test cases or build manual tests, including the costs of recruiting, hiring, paying, and retaining trained experts.
- **Training costs**—depending on which test automation product is selected, the user may need considerable training to become proficient at writing scripts for automated testing. Alternatively, companies may elect to hire professional services firms to handle the initial automated test creation.
- **Integrated data tables.** One of the key benefits of automating functional testing is the ability to pump large volumes of data through the system quickly. But it is also important to be able to manipulate the data sets, perform calculations, and quickly create hundreds of test iterations and permutations with minimal effort. Your enterprise should look for products that offer integrated spreadsheets with powerful calculation capabilities.
- **Clear, concise reporting.** The ability to run a high volume of tests is of little benefit if the results of the tests are not easy to understand or interpret. Testing products should automatically generate reports that display all aspects of the test run and explain the results in an easy-to-read format. The reports should provide specifics about where application failures occurred and what test data was used; present application screen shots for every step to highlight any discrepancies; and provide detailed explanations of each checkpoint pass and failure. It should also be possible to share these reports across an entire QA and development team with no modifications.

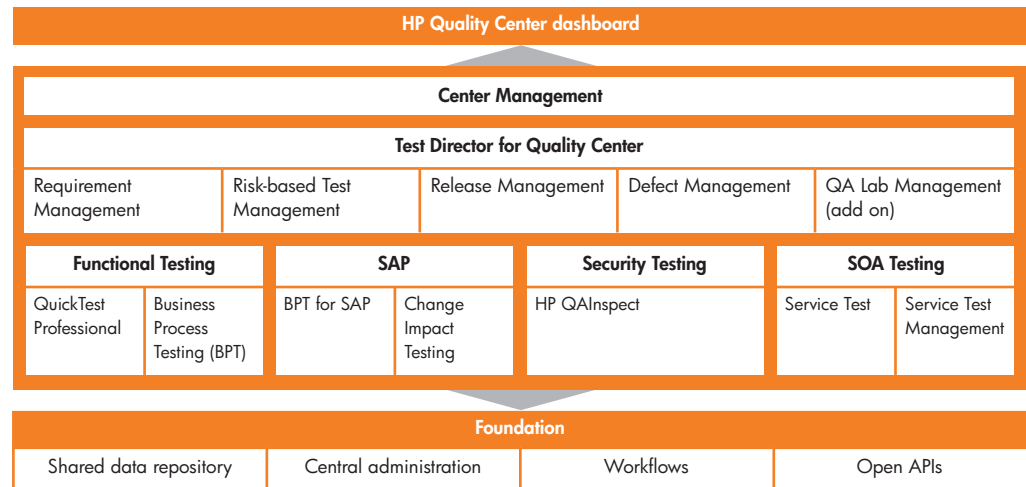
When weighing the potential rewards of automation, it is important to consider intangible benefits, such as higher morale and job satisfaction among testers, improved customer satisfaction and loyalty, and an enhanced reputation for reliable software among end users.

## Evaluating automated testing software: what to look for

Many vendors offer test automation products. Every solution has its own strengths and weaknesses, unique features, and market niche. Each enterprise's specific requirements will determine which option is the best fit. However, there are several key capabilities that should be included in any test automation product:

- **Scriptless representation of automated tests.** The testing product should offer a point-and-click interface for accessing and interacting with the application components under test—as opposed to presenting line after line of scripting. Testers should be able to visualize each step of the business process and view and edit test cases intuitively; this will shorten the learning curve for testers and help QA teams meet urgent deadlines.

Figure 2: HP Quality Center software components



## HP Quality Center software

HP Quality Center software provides a complete, Web-based, integrated system for performing QA across a wide range of IT and application environments. It includes an integrated suite of role-based applications and best practices, as well as an open, scalable and extensible foundation—all designed to optimize and automate key quality activities. HP Quality Center software components include solutions for requirements, test, defects management, and ERP/service-oriented architecture (SOA); functional, regression, and service testing; and business-process design and validation.

## HP Functional Testing software

The full HP Functional Testing software solution includes both HP QuickTest Professional software and HP Service Test software, which are sold as separate packages. Together they allow your enterprise to automate functional tests, enabling your IT teams to quickly identify defects and verify that applications work correctly prior to going live.

### Visibility into application readiness

HP QuickTest Professional software is our advanced automated testing solution for building functional and regression test suites. Its innovative, zero-configuration, keyword-driven approach to structured automation provides the ability to use natural language to build tests that verify user interactions and determine that business processes work as designed. It is one of the industry's best solutions for functional and regression test automation for practically every software application and environment. It enables your testers to capture, verify, and replay user interactions automatically to identify defects.

HP QuickTest Professional (QTP) software ActiveScreen technology offers one of the industry's shortest learning curves for testers. QTP satisfies the testing needs of both technical experts and business analysts, enabling your company to deploy higher-quality applications faster, with reduced risks and cost.

HP QuickTest Professional version 9.5 software provides support for additional environments and includes the following core enhancements:

- Process guidance provides the ability to embed a user guide within QTP and document and propagate best practices as part of the test development process, with interactive help to walk users through the activities and link the user to the right application areas within QTP. We ship QTP with two built-in processes—keyword-driven processes and business process testing—and you can create your own custom processes and propagate those as well.
- Maintenance Run Mode is designed to address the production phase where tests need to be maintained as the application changes. This new execution mode allows you to run the tests against the application, and instead of its failing where the application changes, you get a pop-up wizard that guides you on how to change the test on the fly, the reason for failure, and choices on how to fix it. If the changes are more extensive than what can be fixed on the fly, you can add comments and go back to it later.

**Figure 3. Environments supported by HP QuickTest Professional software**

Classic	Common	Emerging
Custom C/S <ul style="list-style-type: none"> <li>• PowerBuilder</li> <li>• Delphi</li> <li>• PowerBuilder 9, 10, 10.5, 11</li> </ul> ERP/CRM <ul style="list-style-type: none"> <li>• PeopleSoft Windows</li> <li>• Siebel 5, 6</li> <li>• GUI clients</li> <li>• Oracle® GUI forms</li> </ul>	Web-related environments <ul style="list-style-type: none"> <li>• IE, Netscape</li> <li>• JDK, Java Foundation Classes, AWT</li> <li>• ActiveX</li> </ul> Custom client/server <ul style="list-style-type: none"> <li>• Windows/Win32</li> <li>• Visual Basic</li> <li>• Stingray</li> <li>• IBM VisualAge Smalltalk</li> </ul> ERP/CRM <ul style="list-style-type: none"> <li>• Oracle 11i</li> <li>• JD Edwards Web client</li> </ul> Legacy <ul style="list-style-type: none"> <li>• 3270, 5250 emulators, VT100</li> </ul> Operating systems <ul style="list-style-type: none"> <li>• Windows 2000, 2003, XP, Vista®, Vista (64-bit)</li> </ul>	ERP/CRM <ul style="list-style-type: none"> <li>• SAP</li> <li>• Siebel 7.x and 8.x</li> <li>• PeopleSoft 8.x</li> <li>• Oracle 12i</li> </ul> .NET <ul style="list-style-type: none"> <li>• WPF from .NET 3.0</li> <li>• Winforms</li> <li>• Webforms</li> <li>• HTC/Viewlink</li> <li>• Delphi 8 .NET Winforms</li> </ul> Ajax-Web extensibility <ul style="list-style-type: none"> <li>• Web services</li> <li>• Macromedia flex</li> <li>• Wireless</li> <li>• Java SWT</li> <li>• Citrix</li> <li>• VMware desktop support</li> <li>• Mozilla Firefox 2.0, 3.0</li> </ul>

- New QuickTest panes show the list of actions and flows in a test within one flow pane; the resource pane allows test assets and resources used by the test to be easily viewable and manageable; and a keyword pane shows the keywords used by the test in one view, so you can drag and drop test objects into the test and share keywords.
- Checkpoint Management allows you to manage the object repository and checkpoints within the object repository, and it allows shared output using a single UI to view the shared object repository.
- Web Extensibility is a simple application programming interface (API) to extend the capabilities of QTP and support Web controls that are not supported out of the box. Ajax is an example of a non-standardized technology. Web Extensibility is the best way to address Ajax and to create support for those Web controls.
- All-in-one installation is now provided on one DVD for silent installation via Microsoft Installer (MSI).
- Extended functionality is available in Business Process Testing for learning SAP business processes, componentizing the test into business process components, and detecting application changes.

The enhancements listed above complement the functionality available in previous versions of QTP.

- QTP provides support for HP Business Process Testing software to create keyword-driven, component-based tests, allowing subject-matter experts and HP QuickTest Professional software engineers to work together.
- Testers can create and use Multiple Application Areas for each part of the application.
- A Function Definition Generator quickly documents and registers new user-defined functions for tests and components.

- QTP provides an Open XML report format for test results.
- It provides the ability to pass data in tests and components using parameters.
- An Object Repository Comparison Tool and Object Repository automation are included for easier management.
- Navigate and Learn capabilities simplify object repository creation.
- QTP provides support for the broadest range of technologies in the industry (see Figure 3).
- An HP QuickTest Professional software script editor tool enables editing of multiple test scripts.
- There is a single license mechanism for HP QuickTest Professional software and add-ins.

### HP Service Test software for functional testing of SOA services

Service-oriented architectures (SOAs) provide a set of services that can be shared and re-used across application development initiatives. SOA solutions enable your organization to:

- Coordinate services instead of supporting large, monolithic applications
- Decouple applications from underlying infrastructure
- Shift the orientation from technology to business

HP Service Test software provides a solution that enables QA engineers to simplify the ongoing testing of SOA services and reduce scripting through automation. Users can efficiently enable compliance with corporate standards, even in organizations that use multiple development tools. HP Service Test software allows you to validate the application independence of a GUI, allows you to begin testing earlier in the lifecycle, and reduces the cost of testing.

Figure 4. HP QuickTest Professional testing functions

#### Testing functions

ActiveScreen	Open multiple function libraries
Analog	Process guidance
Auto-documentation	Rapid object import
Checkpoint management	Record/Replay
Code editor and debugger	Recovery Manager
Function generator	Run wizard
XML object repository	Script and function libraries
Information flow pane	ScriptFusion
Integrated data table	Shared object repository
Keyword view	Business process testing
Maintenance run mode	VBScript
Numerous checkpoints	XML reports
ODBC and Excel connectivity	Environment extensibility
Web Extensibility	Resource pane
Automation object model	

Service Test allows you to expose “headless” services through contract inspection and to provide support for testing from the unit level through complex business processes. The scripts created can be used for both functional and performance testing. HP Service Test software enables organizations to conduct functional test and regression test automation, and it addresses every major software application and environment. The solution satisfies the needs of both technical and non-technical users, and it enables your IT organization to deploy higher-quality services faster, cheaper, and with less risk.

IT can rely on HP Service Test software for functional testing and HP LoadRunner software for testing the performance of services. IT has unique, shared needs for both functional and load testing as well as specific needs for each, and HP integrates HP Service Test software and HP LoadRunner so QA can efficiently manage functional and performance testing of services.

### HP Business Process Testing software

In addition to our functional testing solutions just described, HP Business Process Testing (BPT) software provides higher-level, scripted automated functional testing capabilities to business analysts so that they too can be part of the quality process. HP Business Process Testing software works hand-in-hand with HP QuickTest Professional software to bring non-technical subject-matter experts into the quality process early and in a meaningful way. BPT allows you to start your test automation even before the application is available. It empowers your entire testing team to create sophisticated test suites with less training. And it reduces test cycle times and test maintenance costs.

HP Business Process Testing software reduces the overhead for automated test maintenance and combines test automation and documentation into a single effort. With this solution, organizations are able to measure the quality of application deliverables from abstract business definitions defined within the HP Business Process Testing software framework. Subject matter experts can focus on creating high-level test flows that mirror actual business processes, while quality engineers concentrate their efforts on areas that enable automation.

HP Business Process Testing software also includes:

- A framework for building reusable, data-driven test components
- Support for manual, keyword-driven and scripted components
- A Web-based repository for sharing tests and components
- Pure manual components and full manual HP Business Process Testing software execution
- Permissions and access control enforcement
- An easy automation infrastructure for HP Business Process Testing software generation in HP QuickTest Professional software
- An API for creating/managing business components as a “technology preview”

BPT also has extended capabilities for creating and updating tests for SAP applications. The HP quality management solution for SAP applications provides a repeatable and risk-mitigated approach to implementing, upgrading, or changing your SAP applications. The solution is powered by HP Quality Center, one of the leading quality management

software products, and HP QuickTest Professional, one of the leading functional software packages. HP Business Process Testing extends these products to make SAP test creation and maintenance easier than ever before, even for non-technical users.

BPT accelerates SAP implementation and upgrade projects; involves subject matter experts in the quality process; increases the go-live decision confidence; and reduces the time, cost, and risk of making changes to production systems. It supports all key SAP technologies; is easy for non-technical users to use; intelligently breaks tests into small, reusable components; detects SAP application changes; and updates your tests.

### **The pros and cons of manual functional testing**

Though the benefits of automated testing are many, there are some situations where manual testing may make sense from a functional or cost perspective. To make the decision between automated and manual testing, it is important to understand the strengths and weaknesses of manual functional testing processes.

Some of the disadvantages of manual testing include:

- Manual tests take too long. Limited IT resources combined with tight delivery schedules make manual testing simply too time-consuming to be effective in meeting business objectives. With manual testing, your testers and developers must tediously document each step of a test case and then manually execute each test and reproduce defects, which rapidly consumes valuable time and resources.

- Manual tests provide incomplete coverage. The proliferation of platforms, operating systems, client devices, business processes, and data sets wreaks havoc on manual testing processes. As testers begin to combine multiple data sets, operating environments, and business processes, they create an explosion in the number of test cases that need to be executed to verify the functionality of an application. This makes it very difficult to perform verifications of all of the multiple permutations. And, when development fixes are introduced, manual regression testing takes too long to make complete regression tests practical.
- Manual tests introduce higher risk. Manual testing processes are subject to a higher risk of mistakes and oversights than computer-driven processes. People get tired, they make errors entering data, they don't always code the tests correctly, and they don't always have the time to test everything that should be tested.

But for some environments, manual testing may be an appropriate choice. For example, manual testing may be appropriate for applications that are under heavy development, that frequently change their UI or logic, and that are built on top of non-supported technologies or homegrown UI toolkits, or for lower-level tasks such as system-level verifications.

Benefits of manual testing include:

- Manual tests can provide fast access to testing information. Testing can be started before the application is fully stable, providing faster feedback to the development team.
- Manual tests provide the ability to perform simultaneous testing. Manual testing can be done simultaneously with the development and the debugging of automated scripts.
- Manual test scripts are easy to create. These could later be converted to automated scripts.
- Manual tests are easy to understand for all users, and they can be provided to business users for test validation and to developers as requirements documents or steps that lead to the discovery of bugs.

## Checklist: five keys to successful automated testing

Even when there is clear evidence that automating a testing effort is economically justified, it can be difficult to determine how best to approach the transition to automated testing processes. This section outlines five fundamental principles for implementing automated software testing processes:

1. Complete a test plan document. Understanding the goals of the application to be tested is critical to the success of any testing effort. This includes thorough up-front planning to verify that test requirements are implemented correctly. HP TestDirector software provides the ability to manage both test cases and requirements for all applications to be tested.
2. Subdivide the tests into test cases to be automated. It is probably impossible for your organization to automate all aspects of a test plan. Automated testing should be focused around the complex and critical business processes that map to functionality within an application as designed per the requirements. Many organizations find that they are automating nearly 60 percent of their total number of test cases, leaving 40 percent of tests to be conducted manually.
3. Create automated tests. Using HP QuickTest Professional software, users can create tests without having to do any actual scripting. HP QuickTest Professional software captures the business process for the target application itself and allows users to create test flows that can then be saved into HP TestDirector software and managed via the Web.
4. Do data-driven tests to expand test coverage. Using the built-in data-table feature of HP QuickTest Professional software, your testers have the ability to create data-dependent tests that use specific keywords stored in Excel spreadsheets to populate fields in an application. This capability allows your testers to drive massive volumes of test data through an application.
5. Add verifications to the tests. The actual pass or fail criteria for a test are then added to the HP QuickTest Professional software tests. The criteria include verifications of the front-end of the application, the middle tier, or the back-end database. Built-in database verification confirms the values stored in the database and verifies transaction accuracy and the data integrity of records that have been updated, deleted, or added.

## Summary

Functional testing need not be a time-consuming or expensive proposition. By automating functional testing, your enterprise can take major steps forward in your ability to improve automated business processes. Your development and QA teams can increase both the speed and accuracy of the testing processes, and your IT department can achieve a higher ROI from software projects while reducing risk.

By selecting HP QuickTest Professional software or HP Service Test software as your test automation platform, your enterprise can take advantage of one of the most sophisticated yet easy-to-use functional testing technology solutions on the market.

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To learn more about HP functional testing solutions, visit:  
[www.hp.com/go/software](http://www.hp.com/go/software)

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4AA1-1390ENW, July 2008



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