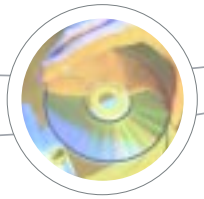
Software Quality Assurance

Perhaps the highest return technology investment that executives can make



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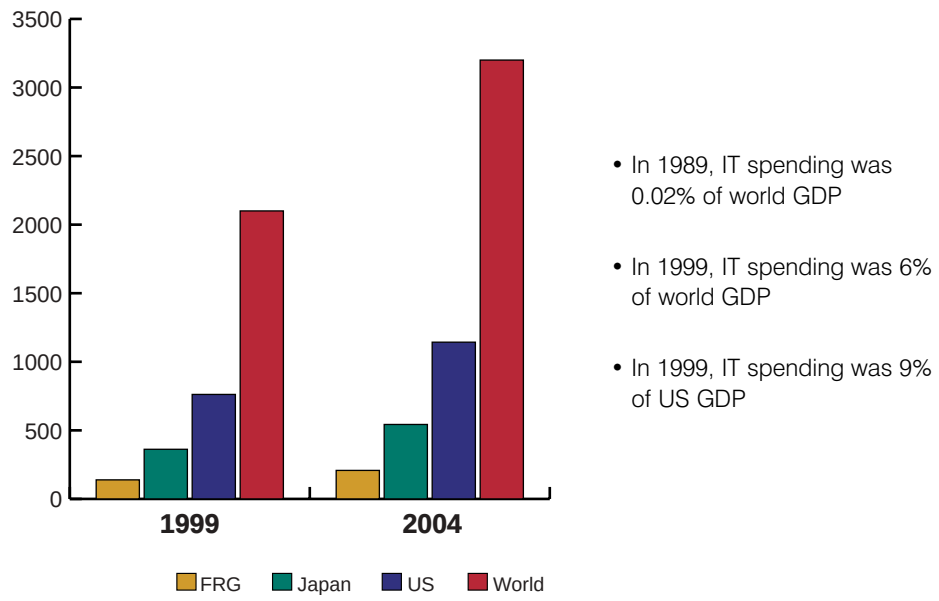
Abstract: The increasing dependence of global economic and social systems upon information technologies is now almost axiomatic. Frequently overlooked however, is software's pivotal role in enabling all these information technology (IT) structures to function and collaborate. Today, software must simply be as predictable and reliable as any essential utility. The final arbiter in software's transition from technology chic to essential utility is Software Quality Assurance (SQA). This paper, intended primarily for senior business executives, will:

- Briefly examine the operating impact SQA exerts on revenues, costs and cash flows. Returns are much more than cost based.
- Briefly discuss the strategies, tactics and methods by which Software Quality Assurance may be most effectively implemented. Rigorous methods must be coupled with implementation flexibility.

Background data: IDC data from their December 2000 industry survey pegged the Information and Communication Technology (ICT) market segment at $2.1 trillion, growing to over $3 trillion by 2004 *(Figure 1)*. Even allowing for market perturbations, this is indicative of the global pervasiveness of ICT, which in turn *is all software enabled*.

Figure 1



At least one other conclusion emerges from this data: If 6% of world GDP is IT spending, then over 90% is not. This suggests most of the world GDP is derived from those goods and services that selectively use IT in the conduct of their normal or primary business, which is not Information Technology. For 90% of the world, IT is not a core competency. Even fewer appreciate the impact of software quality.

For the purposes of an SQA discussion, it is probably helpful to over simplify the world into three levels of IT involvement: ***Developers, Providers and Users***. Developers are considered the most technologically sophisticated, Providers the next most and the Users the least. There are vastly more Users than Providers or Developers, and this fact underscores the urgent need for SQA. Users are fundamentally technophobes and they expect the software to work, having little patience when it does not. If the software does not work, then everyone's business suffers, Developers, Providers and Users alike. In fact, the 2002 U.S. Dept. of Commerce study by the Research Triangle Institute (RTI) found that users experience 70% of the costs of poor software.

Definitions: Basically, while Information Technology may be the core business of Developers and Providers, it most definitely is NOT the core business of Users, that other 90% of the world GDP. Users outnumber everyone else, which leads nicely to a real world definition of software quality:

- **Software Quality** is simply the conformance to the customer or user's implicit and explicit requirements.
- **Software Quality Assurance** is simply the systematic and repeatable process discipline(s), which provide the context for continuous and proactive quality improvements. Testing provides data; QA provides the context to make the data meaningful.
- A **Software Departure** is any software or software associated event or result that deviates from a required or expected outcome. Understanding and predicting departures is the goal of SQA.

From the SQA perspective, "compliance with specification" is not inherently indicative of the customer/user requirements. The "specification" is but one component of quality.

SECTION 1:

Investing in SQA: Reviewing the annual reports and financial data of a cross section of Fortune 500™ Developers, Providers and Users reveals that current spending on Software Quality Assurance (including testing) is under 1% of operating revenues *(Figure 2)*. Typical spending as a percentage of operating revenues as shown on the P&Ls are:

Figure 2

	% Total P&L			
IT involvement	**%R&E**	**%SG&A**	**%EBIT**	**%SQA**
Developers	15-20%	30-45%	25-45%	1-2% in R&E $
Providers	8-15%	25-25%	10-25%	<1% in SG&A $
Users	4-10%	20-30%	0-25%	<1% in SG&A $

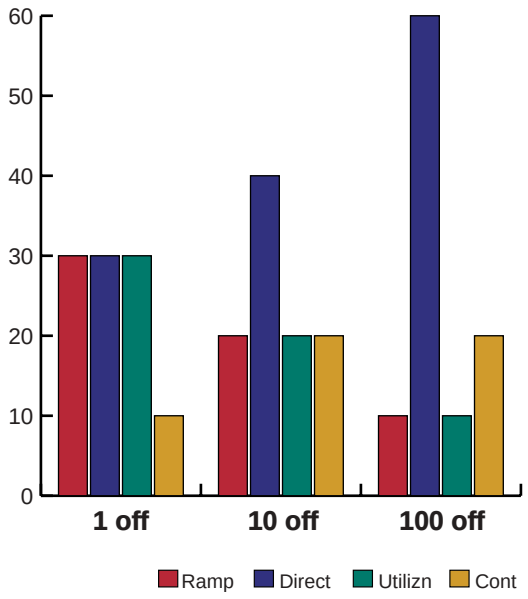
It is tempting to infer that the increasing frequency of software departures bears some relationship to a chronic under investment in SQA. Without probing the larger question of appropriate investment levels per se, it is quite safe to suggest that all SQA investments must be maximized for investment return and margin contribution.

Operating Impact Considerations: Whenever software departs from the required or the expected, some portion of the business operating performance suffers. Whether the result is catastrophic shut down or simple delay, all software departures impact revenue, costs and cash flows. Most businesses develop their own spreadsheets to project the effects of software departures on revenues, costs and cash flows. Most also appreciate that the SQA expenditures they do allocate significantly improve overall cost, revenue and cash flow predictability. Typically, software departures can adversely impact up to 20% of operating costs and in some instances up to 100% of revenues. Investment in SQA frequently emerges as the highest return technology investment senior executives can make. The question quickly becomes selecting the most efficient SQA investment tactics and their associated financial treatments. For example, if the investment in software is used in revenue generation, it may qualify for capitalization. Tactically, while nearly all businesses have some internal SQA function, nearly all find the selective use of functional outsourcing, consulting services, laboratory services and staff augmentation significantly improves business flexibility, margin contribution and investment return.

To help clients select and refine their investment options, Ajilon Software Quality Partners can invoke several different, proprietary models, developed to describe and adapt to nearly all business and operating structures. Working in very close collaboration with clients, we help define the costs, margin contribution and returns of the various SQA investment options by evaluating ***all appropriate costs and revenue implications.***

Simple cost implications: By way of example, looking only at the SQA activity based costs and using our most simple costing model, we can break the SQA investment into 4 buckets *(Figure 3)*.

Figure 3



THE 4 SIMPLE COST BUCKETS:

Cost 1: Ramp Up OH — start up each effort

Cost 2: Direct Project — salaries, etc.

Cost 3: Utilization OH — inherent overcapacity

Cost 4: Continuity OH — proactive audit trail

Frequency Factor: How often is SQA the active focus of the business or development effort?

- 1x/year has up to 70% OH costs
- 10x/year has up to 60% OH costs
- 100x/year has up to 40% OH costs

While mileage always varies, typical SQA functional outsourcing cost savings fall in the 5-20% range, fundamentally from improvements in overhead, schedule and expertise efficiencies. Additional second and third order benefits that derive from a refocus of management back to the core elements of the business and the revenue stream are not included.

Simple cash flow implications: In addition to the cost vectors, SQA investment models should also reflect the cash flow predictability of the business. A software departure nearly always results in some form of productivity interruption. The result is lost revenues and increased costs. The effects of cash flow perturbations last long after the causal software departure. *(Figure 4)*

Figure 4

- **Lost revenues plus increased costs combine to kill cash flow**
- **EXAMPLE: Assume your business does $10K/day in revenues at 10% OP/EBIT-(Good day is get 10, keep 1)**
- **The full cash flow impact of downtime is the sum of Revenues plus Costs**

	Good Day	Bad Day
Revenues	$10,000	$0
Costs	$9,000	$9,000
EBIT/OP	$1,000	<$9,000>

- **Good day = bring in $10K, keep $1K**
- **Bad day = bring in $0 but incur $9K costs**
- **ONE Bad day takes TEN good days to recover**

Factoid: Over 80% of the businesses that failed between 1990 and 2000 were profitable, they blew their cash flows!

SECTION 2:

Effective Software Quality Assurance has feet in three camps: ***Software Development, Project Management and Software Development Life Cycle.*** Fortunately independent standards are available which define competence levels in each:

- the Carnegie Mellon University **SEI/CMM**℠ guidelines for software development,
- the Project Management Institute **PMBOK**© project management guidelines,
- the **SDLC** taxonomy, an extension of SEI/CMM

Ajilon Consulting is unique in the industry in that we develop and provide SQA services drawn heavily from and traceable to these three disciplined methodologies.

SEI/CMM: Most Developers and Providers are well aware of the Software Capability Maturity Model (SEI/CMM) developed by Carnegie Mellon University in conjunction with the U. S. Government in the late 1980's. Simply stated the SEI/CMM established the standard hierarchical criteria by which software development environments can be classified *(Figure 5)*.

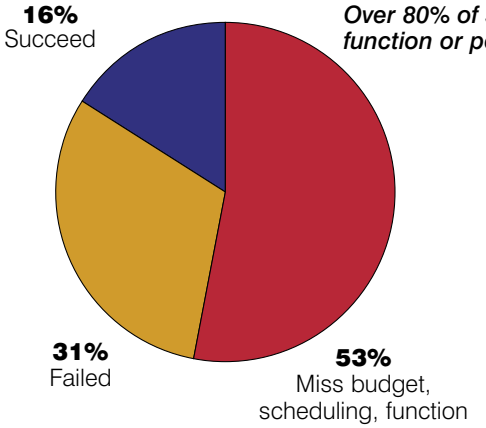
Figure 5

CMM Level	CMM Name	Characteristics
Level 1	Initial	Ad hoc development and testing efforts
Level 2	Repeatable	Basic management and process structure
Level 3	Defined	Inter-group mgt., process & org. structure
Level 4	Managed	Quantitative management, processes and quality
Level 5	Optimizing	Change & process management, defect prevention

The portions of the SEI/CMM dealing with SQA similarly mirror the increasing rigor associated with each SEI/CMM level. Significant SQA discipline begins to emerge in Level 2 and builds to a high degree of sophistication in Levels 4 and 5. Guidelines throughout SEI/CMM stress the need for functional autonomy for the SQA function to insure data integrity and the elimination of organizational bias. Interestingly, in most Developer, Provider and User organizations, the SQA function is not a core competency. This challenge is further compounded by the reality that skilled SQA people are in high demand.

Carnegie Mellon data collected in the late 1990's indicated the state of software development, as measured against the SEI/CMM model, to be predictably skewed toward the lower end. This likely contributes to software development projects that fall short of expectations or fail *(Figure 6)*.

Figure 6



Over 80% of software falls short of planned function or performance!

1999 Standish Group

CMM Level	% SW Devel. Efforts
Level 1	62.0%
Level 2	23.0%
Level 3	13.0%
Level 4	2.0%
Level 5	0.4%

CMM Data

In the face of ever increasing software complexity, more Developers, Providers and Users are utilizing outsourcing to augment their thin SQA resources as they confront the software departures in their respective businesses.

PMI: Founded in 1969, the ***Project Management Institute***, PMI, is the most recognized source of project management standards. The source pool for much of PMI's training materials and standards is the PMBOK or Project Management Body of Knowledge. This evolutionary pool captures best practices for all types of project management elements.

SDLC: The SDLC extensions (Software Development Life Cycle) to the SEI/CMM define the resource and focus shifts that occur throughout the software development life cycle. The SDLC outlines the different phases of software development and helps define the shifts in focus and responsibilities along the time continuum. A simplified depiction would include 7 SDLC phases, the SQA focus and normalized costs *(Figure 7)*:

Figure 7

SDLC Phase	Req'ts	Design	Code	Test	Deploy	Operate	Retire
SQA Focus	Prevention		Correction		Salvage		Maintenance
Total Quality Costs *(normalized)*	0.75x	1.0x	2.0x	30x	100x	10x	5x

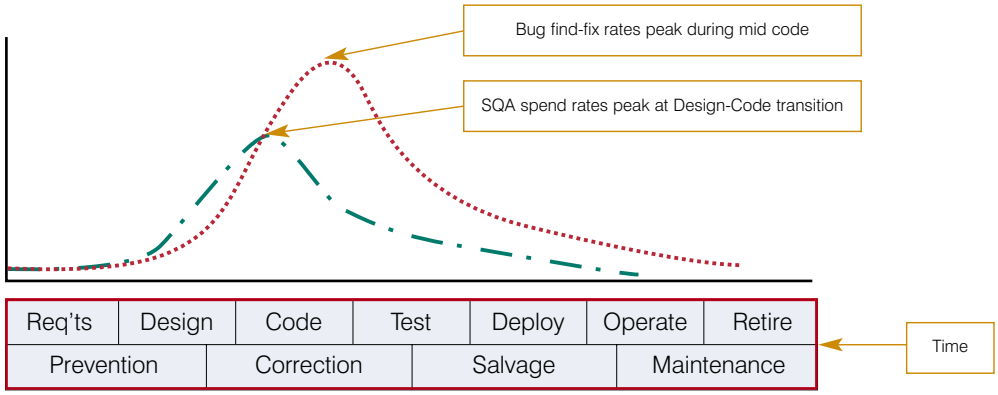
Using the SDLC framework provides an opportunity to frame the full business impact of software quality. While the SQA focus changes considerably throughout the SDLC, industry data is consistent in recognizing that the total costs to business of poor quality increase dramatically with delays in implementing SQA within the SDLC. Preventing software departures early in the SDLC is best. The costs of poor quality go well beyond the "find-fix" costs (which merely blow a given IT or R&E budget) and extend into the rest of the business to include added operating costs and lost or delayed revenues. The cash flow implications of unplanned operating costs or unachieved revenues are very significant. Using data collected from Software Engineering Institute studies, industry analysts and our own client experience, we express these costs using a normalized cost function. For example, it can be up to 30 times more expensive to fix something in ***Test*** than to have prevented it in ***Design***.

PMM: Drawing heavily from PMI standards, Ajilon Consulting has created a unique ***PMM or Project Management Methodology*** that focuses on the specific requirements of an effective Software Quality Assurance process. The PMM allows mapping different levels of project maturity to client specific needs, the SEI/CMM (Capabilities Maturity Model) and the SDLC (Software Development Life Cycle). Working in close collaboration with clients, Ajilon Consulting can define and implement SQA processes that meet both current and future client requirements. The adaptability of our PMM permits Ajilon Consulting to deliver service levels across a full range from basic industry standard SQA service levels to full custom SQA service levels.

Optimizing SQA and Software Development Processes: Data from highly successful software development projects (on schedule, on budget, fewest departures when operational) provides excellent insight into their success. Characteristic of these successful development projects is the high ROI and margin contribution achieved by eliminating departures early in the SDLC. Here we overlay the familiar "bug rate tracking" curve with the associated SQA

spend curve *(Figure 8)*. Design projects that include SQA as a part of the functional specification experience fewer departures, lower total costs and faster time to market and profitability. Conversely, under performing software projects frequently experience shifts to the right of these curves, accompanied, as previously discussed, by increased total business exposure.

Figure 8



Ajilon Consulting combines industry best practices (SEI/CMM, PMBOK, SDLC, PMM) with over 20 years of front line Software Quality Assurance experience, including a fully functional 24x7 laboratory to deliver predictable softw are and business results for our clients. Clients choose from a selection of services (functional outsourcing, consulting, laboratory services or staff augmentation) and a selection of delivery options (on-site, local or remote) to implement their most effective SQA functions. Ajilon Consulting is a complete Software Quality Assurance partner.

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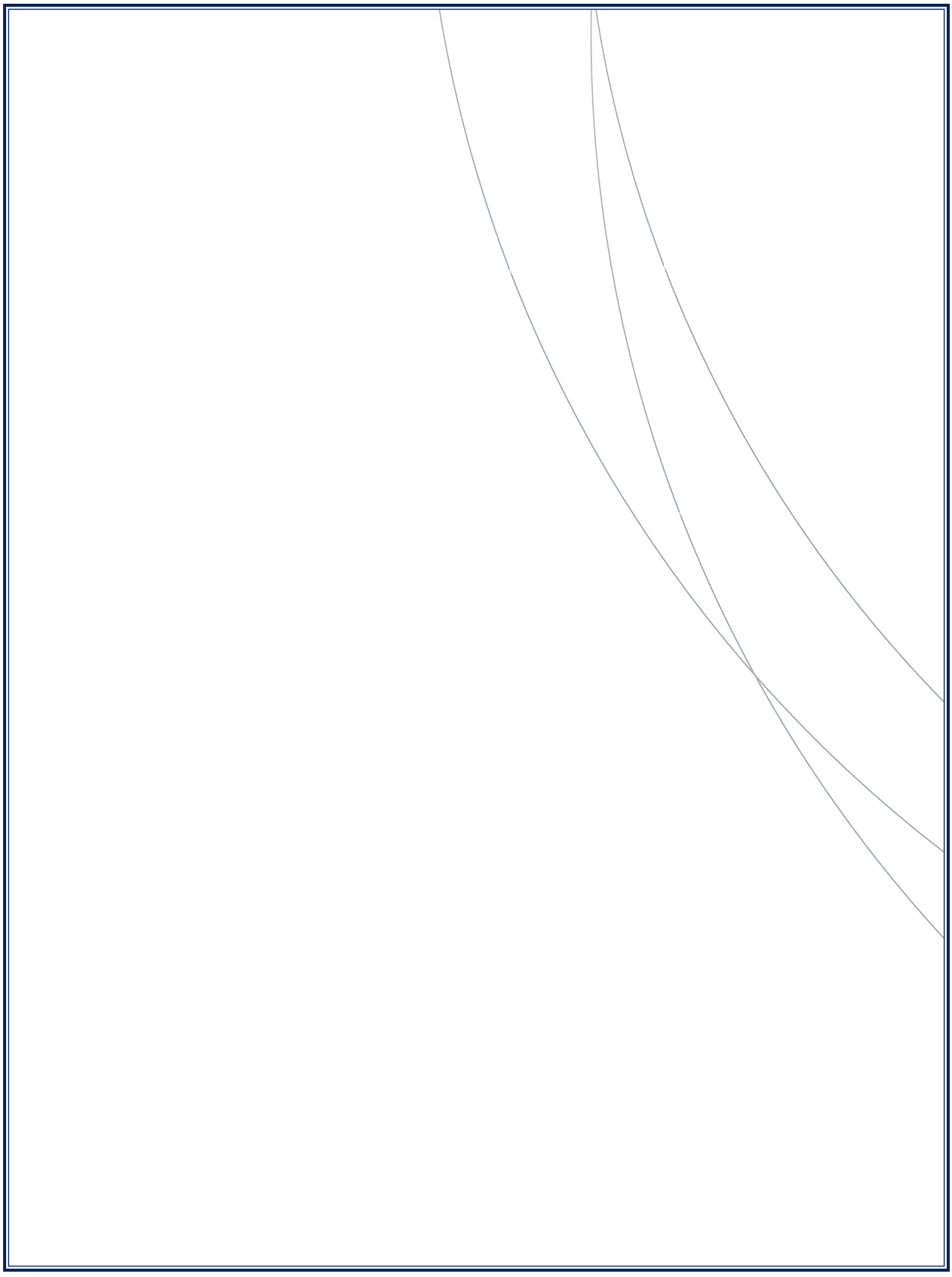

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