The 2001 High Maturity Survey

Mark C. Paulk
Dennis R. Goldenson
David M. White
Michael J. Zuccher

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Carnegie Mellon
Software Engineering Institute

Pittsburgh, PA 15213-3890

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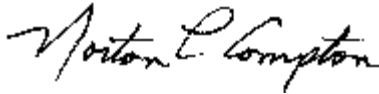Michael J. Zuccher

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The ideas and findings in this report should not be construed as an official DoD position. It is published in the interest of scientific and technical information exchange.

FOR THE COMMANDER

Norton L. Compton, Lt Col, USAF
SEI Joint Program Office

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Executive Summary

Abstract

Over the last several years the Software Engineering Institute has investigated the high maturity practices of Maturity Level 4 and 5 software organizations via assessments, site visits, workshops, and surveys. This report summarizes the observations from the 2001 survey of high maturity organizations. Areas covered in the survey include management practices, engineering practices, quantitative analysis, process management, people issues, and background information. The observations in this report cover a variety of engineering and management practices, including issues outside the scope of the Capability Maturity Model for Software.

1 Introduction

During the last several years, the Software Engineering Institute (SEI) has had the privilege of working with a number of high maturity software organizations, as measured by the five-level Capability Maturity Model® for Software (CMM®) [Paulk 95], in workshops, conferences, assessments, and site visits. The SEI hosted workshops for Level 4 and 5 organizations in 1996, 1997, 1999, and 2001. This report documents the results of the 2001 survey of high maturity organizations.

When the first profile of Maturity Levels was published [Kitson 92], no organization had been assessed at Level 4, and only one organization, IBM's Onboard Shuttle [Billings 94; Fishman 97; Krasner 94; Paulk 95, Chapter 6], had been evaluated as Level 5 using the software capability evaluation method.

Six high maturity organizations participated in the 1996 workshop for Level 4 and 5 organizations. The results of that workshop are summarized in Appendix A of "Practices of High Maturity Organizations," which primarily reports the 1998 survey of high maturity organizations. [Paulk 99a] The 1997 workshop was held as part of the Software CMM Version 2 effort, and the discussion points are summarized at <URL: http://www.sei.cmu.edu/cmm/cmm-v2/cmm.v2.html> in the Software CMM v2 archive. The 1999 high maturity workshop was held in November 1999 [Paulk 00x]. Representatives from 26 high maturity organizations participated. The 2001 high maturity workshop was held in March 2001 [Paulk 01x]. There were 48 participants, representing 35 high maturity organizations.

While workshops and site visits may provide useful insights into industry practices, they do not necessarily provide a good feel for the breadth of deployment of specific techniques across industry. To obtain a broader perspective on these high maturity techniques, an informal survey was distributed in 1998 to Maturity Level 4 and 5 organizations. At the time of the 1998 survey, the SEI assessment database listed 18 Level 4 organizations and 7 Level 5 organizations, which had reported assessment results.[1] A total of 13 organizations responded to the 1998 survey.

® Capability Maturity Model and CMM are registered in the U.S. Patent and Trademark Office.

[1] A regularly updated maturity profile is available at <URL: http://www.sei.cmu.edu/sema/ profile.html> and high maturity organizations that have given permission are listed at <URL: http://www.sei.cmu.edu/cmm/high-maturity/HighMatOrgs.pdf>.

At the time of the 1999 survey, 61 organizations were known to have been appraised at Maturity Level 4 or 5: 40 at Level 4 and 21 at Level 5. There were 37 respondents to the 1999 survey: 18 organizations assessed at Level 4 and 19 at Level 5.

The number of high maturity organizations has grown steadily over the last decade, and dramatically in the last few years. As of March 2001 when the 2001 survey was distributed, 132 organizations had been appraised at Level 4 or 5. The high maturity organizations that have provided permission to do so are listed in Appendix A of this report. A total of 60 organizations responded to the survey: 25 organizations appraised at Level 4 and 35 organizations appraised at Level 5.

The detailed aggregate data from the 2001 survey is contained in Appendix B. Section 2 of this report summarizes the survey information. Concerns about the consistency and reliability of Level 4 and 5 assessments remain an issue. The current release of the Software CMM, Version 1.1, was released in 1993. A conservative stance was taken in defining Maturity Levels 4 and 5 because of the sparsity of Level 4 and 5 organizations. We have learned much about high maturity practices since then, but Levels 4 and 5 are not as clearly articulated in Version 1.1 as we might wish. This is similar to the situation in 1990, when significant consistency and reliability issues with Level 2 and 3 assessments were reported. This was largely corrected with the publication of Software CMM v1.0 in 1991, which provided a comprehensive description of Levels 2 and 3. The planned release of Software CMM v2.0 in 1997 was halted by the SEI's sponsor in favor of work on CMM Integration, which addresses software, systems engineering, integrated product and process development, and acquisition in a comprehensive model.

The CMM Integration work captures much of what was planned for Software CMM v2. The CMMI v1.1 model was released in March 2002 and is available on the Web at <URL: http://www..sei.cmu.edu/cmm/cmms/cmms.integration. html >. For the installed base of Software CMM users, however, the operational model remains Software CMM v1.1 as released in 1993. Papers, reports, and training are available to alleviate this problem, but interpretation issues remain a concern for Levels 4 and 5.

Those interested in effectively implementing or assessing high maturity practices are recommended to take the SEI courses *High Maturity with Statistics* and/or *Statistical Process Control for Software*, as well as read, in addition to this report, the books, reports, and papers:

- *Measuring the Software Process: Statistical Process Control for Software Process Improvement* [Florac 99]
- *CMM in Practice: Processes for Executing Software Projects at Infosys* [Jalote 99]
- "The 2001 High Maturity Workshop" [Paulk 02]
- "Indian Software Excellence: Education and Process Pay Off" [Paulk 00b]
- "Assessing a Level 5 Organization"[Paulk 99b]

Many of the high maturity organizations are located in India. Respondents to this survey include 32 organizations in India, 24 in the USA, two in China, one in Australia, and one in Israel. Section 3 of this report provides an analysis of some of the differences between organizations in the USA and India.

Section 3 also discusses differences based on maturity level, size of the organization, and major application domains.

2 Practices of High Maturity Organizations

As described in Appendix B, most of the questions in the survey identify whether specific practices are *standardized*, in *common use*, or *not typically used*. Other potential answers included *don't know*, *not applicable*, and *no response*. In this section, the practices of high maturity organizations are summarized relative to their *standardized* or *common use* in contrast to *not typically used* or *not applicable* (*don't know* and *no response* answers are not counted). Detailed response profiles are in Appendices C through F.

2.1 Management Practices

The usage of various management practices by high maturity organizations, according to the 2001 survey, is summarized in Table 1.

Table 1 Percent of High Maturity Organizations Using Management Practices

%	Management Practice
95	independent SQA group
92	SQA function embedded in process (e.g., a role in the peer review method, via buddy system, or as Software Configuration Management entry criteria for baselining)
90	incremental or evolutionary life cycles (e.g., JAD, RAD, spiral development, rapid prototype)
66	chief architect / chief engineer[2]
65	parametric cost models (e.g., COCOMO, Price-S, SLIM)
62	Delphi methods for estimation [Boehm 81]
56	earned value [Thamhain 96]
52	integrated product & process development (IPPD) (a.k.a. concurrent or simultaneous engineering)
34	critical chain (e.g., theory of constraints)
12	Personal Software Process[SM] (PSP[SM]) and/or Team Software Process[SM] (TSP[SM])

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[2]   Both IPPD and chief engineers/architects are mechanisms that can be used to break down organizational barriers [Sobek 98].

Since the emphasis of this paper is on good engineering and management processes, it should also be noted that high maturity organizations typically have a broader scope of improvement concerns than just CMM process issues. Some high maturity organizations, such as Onboard Shuttle and Boeing Space Transportation Systems, were doing process improvement long before the Software CMM was published. Others, such as Motorola India, were started with one business objective being high process maturity [Paulk 00b].

Software Quality Assurance (SQA) is one of the more controversial key process areas in the CMM. There are passionately held, opposing opinions on whether there should be an independent SQA organization, or whether the SQA function should be "built into the process" as part of the quality culture to be expected of high maturity organizations. High maturity organizations *typically* have an independent SQA group and also embed the SQA function in the process. In a typical implementation, process and product assurance are separated, with the "SQA group" focusing on process monitoring, while product assurance is built into peer reviews and/or the configuration management system [Craig 99]. The independent SQA group is usually comparatively small, and it practices sampling rather than providing 100% process and product coverage. The SQA group uses the Level 4 process and product data to identify high-leverage opportunities for auditing.

2.2 Engineering Practices

The usage of various engineering practices by high maturity organizations, according to the 2001 survey, is summarized in Table 2.

Table 2 Percent of High Maturity Organizations Using Engineering Practices

%	Engineering Practice
93	Domain specific software architectures
90	User interface prototyping
85	Independent test groups (i.e., independent of the developers of the software system)
83	Code coverage (e.g., path or branch)
77	Product lines or product families
76	Other systematic reuse (i.e., characterized by an organizational strategy for reuse)
63	Defect prediction, reliability, or release readiness models (e.g., Goel-Okumoto model, basic execution time model)
46	Formal methods (e.g., proof of correctness)
40	Quality function deployment (QFD)

[SM] Personal Software Process, PSP, Team Software Process, and TSP are registered service marks of Carnegie Mellon University.

Formality and data collection/analysis are typical attributes of high maturity inspection processes, and a number of inspection variants have been developed [Fagan 86, Ebenau 93, Freedman 90, Knight 93, Mashayekhi 93]. Gilb's emphasis on inspection sampling [Gilb 93], rather than 100% inspection, to guide process and product decisions is worthy of note, particularly in light of the shift to SQA sampling at the higher Maturity Levels.

It is a concern that in a few cases the respondent did not know what an inspection or walkthrough is. It is also a concern that some comments indicated that peer reviews included managers and/or customers. By definition, "peers" are colleagues at approximately the same hierarchical level in the organization. While designers, coders, and testers may all be considered peers at a professional level, managers who have the authority to hire, fire, promote, and provide raises are not peers, and the inclusion of managers and customers can seriously affect the dynamic of the review. Technical reviews and joint reviews that include managers and customers are desirable in conjunction with peer reviews, but they complement rather than replace the peer review technique.

- user interface prototyping
- independent test groups
- code coverage
- domain specific software architectures
- product lines
- systematic reuse (which includes domain specific software architectures and product lines as implementation strategies)

reliability models [Musa 90].

2.3 Quantitative Analysis

The usage of various quantitative analysis practices by high maturity organizations, according to the 2001 survey, is summarized in Table 3.

Table 3 Percent of High Maturity Organizations Using Quantitative Analysis Practices

%	Quantitative Analysis Practice
98	Pareto analyses
95	Control charts (e.g., XbarR, XmR, u)
79	Cost of quality analysis
62	Other defect taxonomies
54	Regression analysis
54	Orthogonal defect classification (ODC)

%	Quantitative Analysis Practice
46	Prediction intervals
45	Confidence intervals
43	Process modeling or simulation (e.g., system dynamics models, or spreadsheet based "what if" studies of process performance and impact analyses)
37	Analyses of variance (e.g., ANOVA, ANCOVA, MANOVA)
31	Tests of hypotheses
21	Designed experiments (DOE)
10	Quasi-experimental methods
10	Other multivariate methods

Conceptually, Maturity Levels 4 and 5 in the Software CMM are based on statistical process control [Paulk 95, Florac 99], although this was initially stated in terms of operational definitions and comparability in the presence of variation [Humphrey 88]. Level 4 focuses on control—identifying and removing assignable causes of variation in the process, the extraordinary events that prevent the process from performing as intended. Level 5 focuses on improvement—addressing the common causes of variation that are intrinsic to the process. More generally, high maturity organizations appreciate the fundamentals of "statistical thinking"—all work is a series of interconnected processes, all processes are variable, decisions should be based on facts, and a reduction in variation provides improvement opportunities. High maturity organizations are expected to understand the impact of variation on processes and predictability.

The Level 4 key process areas, however, use the term "quantitative management" rather than "statistical control." The CMM distinguishes between thresholds (desired or expected performance, i.e., "voice of the customer") at Level 3 and control limits (what the process can do, i.e., "voice of the process") at Level 4, but the terminology used in the Level 4 practices is "acceptable limits," "expected mean," and "expected variation." Most Level 4 and 5 organizations were initially appraised using a relaxed interpretation of what is meant by "quantitative management" at Level 4.

- "cost of quality" (appraisal, prevention, internal failure, and external failure costs) to determine the effectiveness of their process improvement activities
- orthogonal defect classification (ODC) or other defect taxonomies
- prediction intervals
- confidence intervals
- Pareto analyses
- process modeling and simulations
- quality function deployment (QFD) [Zultner 95]
- designed experiments

- Six Sigma

- analysis of variance such as ANOVA, ANCOVA, and MANOVA

- other multivariate methods

Although controversy remains over what statistical techniques to use when and what business value will be achieved [Ould 96, Carleton 99], the use of rigorous statistical techniques can now be considered an empirical attribute of high maturity organizations. The initial barrier to using rigorous statistical techniques is "informally stabilizing" the process [Barnard 99, Chatmon 99, Florac 99] to refine operational definitions, make processes more consistent, and minimize variation.

The use of measurement data for evaluating the performance of employees is an ongoing concern for high maturity organizations. Unless a "perfect" measurement system is defined that covers all critical performance parameters objectively, measurement is likely to cause dysfunctional behavior if there is any chance of the data being used against people [Austin 96]. Deming, for example, was a strong advocate of statistical techniques, yet strongly averse to performance evaluations [Deming 86].

2.4 Process Management
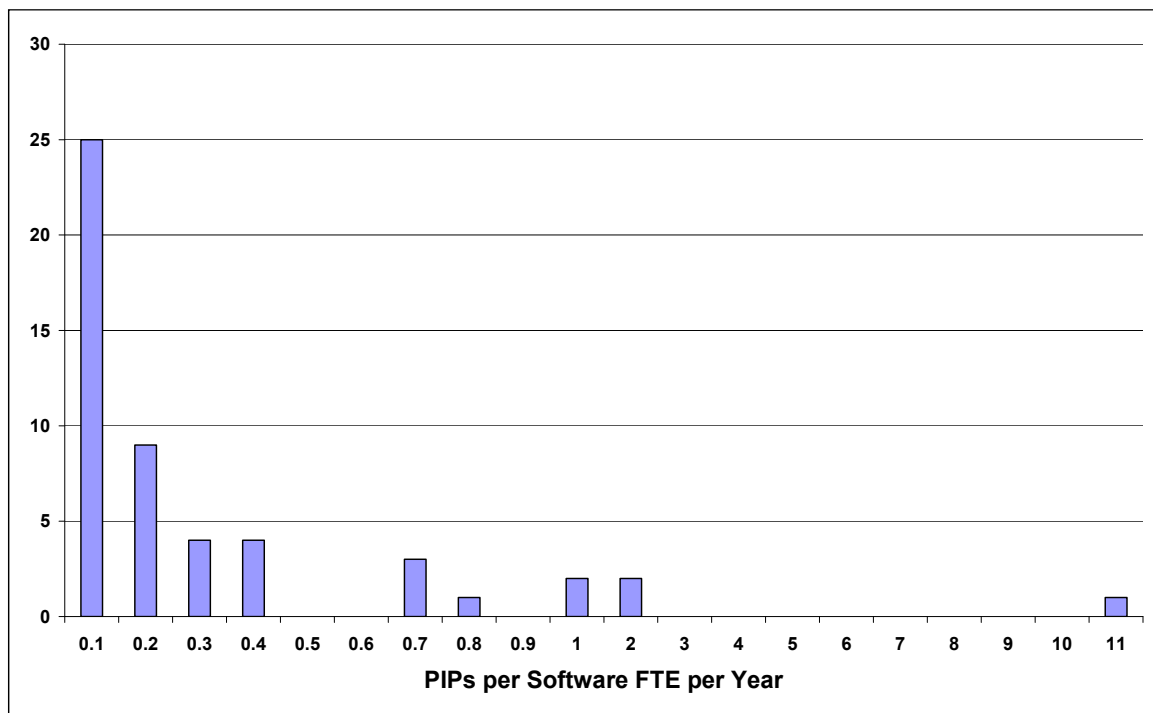
Figure 1 PIPs Per Software FTE Per Year

2.5 People Issues

High maturity organizations recognize the importance of competent people. To quote one participant in the 1996 workshop, "Getting the right person into the right job on the project is still the most important aspect of project success. People are not plug-compatible. The expertise of individuals is critical. Process is an enabler; not a replacement."

Training in high maturity organizations can go to extremes. Mandatory induction training for new hires ranges from 1 day to 14 weeks (with a median of 6 days and an average of 17, indicating a skewed distribution), plus mandatory continuing education requirements (with a median value of 10 days). High maturity organizations typically require training in technical skills, management skills, and relevant application domains; most also require training in interpersonal skills, team building, and negotiating skills. Training includes internally and externally developed training materials, awareness programs, and workshops. A training program with required training is a key process area for CMM Level 3. Many high maturity organizations (half of those responding) have a formal mentoring program to impart skills and knowledge. Common characteristics of a "formal" mentoring program include

- Mentors are knowledgeable and respected.
- Mentors are trained in how to function effectively in the mentoring relationship.
- The expectations for the mentor and the mentored are explicitly identified.
- The mentoring relationship lasts for an extended period of time, typically about one year.
- Mentor and mentored are physically close together, perhaps sharing an office.
- Mentoring is tracked by management.
- Mentoring skill is part of the performance evaluation criteria for the mentor.
- Causal analysis may lead back to a breakdown in the mentoring process as the root cause of a defect.

2.6 Background Information

3 Differences Among Communities of Interest

4 Conclusion

What does it mean to be Level 4 or 5? High maturity organizations

- understand why they are doing what they are doing
- know "what to do" when problems are encountered (don't overreact to special causes – concentrate on finding common causes)
- error-proof their processes to allow for human fallibility
- convert "blame" into "opportunity" (avoid using fear as a motivator)
- balance "empowerment" and "ownership" with "control"
- measure and predict how much further they have to go to achieve their goals

While statistical thinking and an understanding of variation are intrinsic to the definition of Levels 4 and 5, other factors that have been empirically observed—such as capturing product knowledge and addressing the human issues associated with process improvement and change management—are also crucial to continual improvement.

Factors outside an organization's control are also critical to business success. One of the challenges for any organization is dealing with organizational restructuring—mergers, acquisitions, re-organizations, and rapid growth. Each merger or re-organization can dramatically change the culture of the "original" organization. Onboard Shuttle, for example, was part of IBM when initially evaluated at Level 5, then it became part of Loral, then Lockheed Martin, and it has now become part of United Space Alliance—a dizzying journey over the last decade. Process maturity—and executive recognition of that maturity—can help an organization protect the stability and integrity of its processes during the turbulence of organizational change.

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an 00]   provements: An Automated Journey." *The SEPG Conference in India 2000*Bangalore, India, February 22-26, 2000.

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Appendix A: List of Maturity Level 4 and 5 Organizations

The following list of high maturity organizations lists most of the known Level 4 and 5 organizations. As of May 2001, the full list, of which the published list is a subset, includes 132 high maturity organizations, a subset of which is listed below: There are

- 71 Level 4 organizations
- 61 Level 5 organizations

It is interesting to note that 74 of the high maturity organizations assessed are outside the United States.

- Australia: 1 Level 4 organization
- China: 2 Level 5 organizations
- France: 1 Level 4 organization
- India: 30 Level 4 organizations
- India: 39 Level 5 organizations
- Israel: 1 Level 4 organization

Please be aware of the following issues regarding this list.

- The SEI does not certify companies at Maturity Levels.
- The SEI does not confirm the accuracy of the Maturity Levels reported by the Lead Assessors or organizations.
- This list of Level 4 and 5 organizations is by no means exhaustive; we know of other high maturity organizations that have chosen not to be listed.
- The SEI did not use information stored within its Process Appraisal Information System to produce this document.
- The organizations listed gave explicit permission to publish this information.
- No information obtained in confidence was used to produce this list.

The following information is reported by the organization:

- **Full, correct name of the organization** (with acronyms defined), including city and state (or country)

- **Point of Contact**: name and email address

- **Maturity Level assessed**

- **Month and year of assessment** *(Including the form of assessment if different from CBA IPI with Lead Assessor.)*

- **Lead Assessor(s)** *(Lead Evaluators are annotated with LE; some appraisers are both LAs and LEs Some Lead Assessors are now inactive (I) and no longer listed on the LA and LE lists.)*

Alitec, Laval, France
Point of Contact: Jerome Barbier, jeb@alitec.net; Jean Noel Martin, jnm@alitec.net
Maturity Level: 4
Date of Appraisal: July 2000
Lead Assessor(s): Jean-Yves Le Goic

Atos Origin India (formerly Origin Information Technology India Limited), Mumbai, India
Point of Contact: Darayus Desai, darayus.desai@atosorigin.com
Maturity Level: 5
Date of Appraisal: Nov 2000 (CAF-compliant Process Professional Assessment Method)
Lead Assessor(s): (Cyril Dyer - Compita Assessor)

BFL Software Limited, Bangalore, India
Point of Contact: Madhukumar P.S., Madhukumar.PS@bflsoftware.com
Maturity Level: 4
Date of Appraisal: June 1999
Lead Assessor(s): Carolyn Swanson

Boeing Company, Aircraft & Missiles & Phantom Works Southern California, Long Beach, CA
Point of Contact: George H. Kasai, george.h.kasai@boeing.com
Maturity Level: 5
Date of Appraisal: Dec 1997
Lead Assessor(s): Andy Felschow, Jeff Facemire

Boeing Company, Military Aircraft & Missile Systems F/A-18 Mission Computer, St. Louis, MO
Point of Contact: Bruce A. Boyd, bruce.a.boyd@boeing.com; Robert L. Allen, robert.l.allen3@boeing.com
Maturity Level: 4
Date of Appraisal: Nov 1999 (SCE)
Lead Assessor(s): Roy Queen (LE), Jeff Perdue

Boeing Company, Reusable Space Systems and Satellite Programs, Downey & Seal Beach, CA
Point of Contact: Don Dillehunt, donald.d.dillehunt@boeing.com
Maturity Level: 5
Date of Appraisal: Oct 1999
Lead Assessor(s): Andy Felschow, Jeff Facemire

Boeing Company, Space Transportation Systems, Kent, WA
Point of Contact: Gary Wigle, gary.b.wigle@boeing.com
Maturity Level: 5
Date of Appraisal: July 1996
Lead Assessor(s): Steve Masters, Mark Paulk

CG-Smith Software, Bangalore, India
Point of Contact: G.N. Raghavendra Swamy, raghav@cgs.cgsmith.soft.net
Maturity Level: 5
Date of Appraisal: Sept 1999
Lead Assessor(s): Richard Storch

Citicorp Overseas Software Limited (COSL), Mumbai, India
Point of Contact: Makarand Khandekar, makarand.khandekar@citicorp.com
Maturity Level: 5
Date of Appraisal: Oct 1999
Lead Assessor(s): John Sheckler

Cognizant Technology Solutions, Chennai, India
Point of Contact: Emani BSP Sarathy, esarathy@chn.cts-corp.com
Maturity Level: 5
Date of Appraisal: Sept 2000
Lead Assessor(s): V. Kannan

Computer Sciences Corporation (CSC), Aegis Program, Moorestown, NJ
Point of Contact: Wendy Irion Talbot, wirionta@csc.com
Maturity Level: 5
Date of Appraisal: March 2001
Lead Assessor(s): Kathryn Gallucci (LE)

Computer Sciences Corporation (CSC), Civil Group, Greenbelt, MD
Point of Contact: Mel Wahlberg, mwahlber@csc.com
Maturity Level: 4
Date of Appraisal: Jan 2001
Lead Assessor(s): Paul Byrnes (LA & LE)

**Computer Sciences Corporation (CSC), Civil Group, Systems, Engineering, and Analysis
    Support (SEAS) Center,** Greenbelt, MD
Point of Contact: Frank McGarry, fmcgarry@csc.com; Mel Wahlberg, mwahlber@csc.com
Maturity Level: 5
Date of Appraisal: Nov 1998 (SCE)
Lead Assessor(s): Paul Byrnes (LA & LE)

Computer Sciences Corporation (CSC), Defense Group Aerospace Information Technologies, Dayton, OH
Point of Contact: Cheryl Plak, cplak@csc.com
Maturity Level: 5
Date of Appraisal: Feb 1999 (SCE)
Lead Assessor(s): Kathryn Gallucci (LE)

Computer Sciences Corporation (CSC), Integrated Systems Division (ISD), Moorestown, NJ
Point of Contact: Bryan Cooper, bcooper1@csc.com
Maturity Level: 4
Date of Appraisal: May 1998 (SCE)
Lead Assessor(s): Paul Byrnes (LA & LE)

Computer Sciences Corporation (CSC), Tactical Systems Center (TSC), Moorestown, NJ
Point of Contact: Wendy Irion Talbot, wirionta@csc.com; Jeff McGarry, jmcgarr1@csc.com
Maturity Level: 4
Date of Appraisal: May 1998 (SCE)
Lead Assessor(s): Paul Byrnes (LA & LE)

Covansys, San Francisco, CA
Point of Contact: Prasanth Kedarisetty, KPrasanth@Covansys.com
Maturity Level: 4
Date of Appraisal: Jan 2001
Lead Assessor(s): Richard Knudson

DCM Technologies, DCM ASIC Technology Limited, New Delhi, India
Point of Contact: Naresh C. Maheshwari, ncm@dcmds.co.in
Maturity Level: 5
Date of Appraisal: April 2000
Lead Assessor(s): Richard Storch

DSQ Software, Chennai, India
Point of Contact: K.N. Ananth, kna@md.in.dsqsoft.com
Maturity Level: 4
Date of Appraisal: June 1998
Lead Assessor(s): Judy Bamberger

Future Software Private Limited, Chennai, India
Point of Contact: M.G. Thomas, thomasmg@future.futsoft.com
Maturity Level: 4
Date of Appraisal: June 1999
Lead Assessor(s): Pradeep Udhas

HCL Perot Systems, Noida and Bangalore, India
Point of Contact: Rakesh Soni, rakesh.soni@hpsglobal.com
Maturity Level: 5
Date of Appraisal: Feb 2000
Lead Assessor(s): Pradeep Udhas

HCL Technologies Limited, Applications Solutions Development Centre, Chennai, India
Point of Contact: N. N. Jha, nnjha@msdc.hcltech.com
Maturity Level: 4
Date of Appraisal: May 2000
Lead Assessor(s): V. Kannan

HCL Technologies Limited, Core Technologies Division, Chennai, India
Point of Contact: K. R. Gopinath, krg@hclt.com
Maturity Level: 4
Date of Appraisal: Dec 2000
Lead Assessor(s): Krishnamurthy Kothandaraman Raman

HCL Technologies Limited, Gurgaon Software Development Center, Gurgaon, India
Point of Contact: Sanjeev Gupta, gsanjeev@ggn.hcltech.com
Maturity Level: 4
Date of Appraisal: July 2000
Lead Assessor(s): V. Kannan

Hexaware Technologies Limited, Mumbai and Chennai Operations, Chennai, India
Point of Contact: Sulochana Ganesan, sulochana@hexaware.co.in
Maturity Level: 5
Date of Appraisal: Dec 2000
Lead Assessor(s): V. Kannan

Honeywell International, Avionics Integrated Systems (formerly AlliedSignal, Guidance & Control Systems), Teterboro, NJ
Point of Contact: Steve Janiszewski, stephen.janiszewski@honeywell.com
Maturity Level: 4
Date of Appraisal: Nov 1996
Lead Assessor(s): Larry Bramble (I)

Hughes Software Systems, Bangalore and Gurgaon, India
Point of Contact: Gautam Brahma, gbrahma@hss.hns.com
Maturity Level: 4
Date of Appraisal: Jan 2000
Lead Assessor(s): V. Kannan

IBM Global Services India, Bangalore, India
Point of Contact: Asha Goyal, gasha@in.ibm.com; Maya Srihari, smaya@in.ibm.com
Maturity Level: 5
Date of Appraisal: Nov 1999
Lead Assessor(s): Richard Storch

i-flex solutions limited (formerly Citicorp Information Technology Industries Limited aka CITIL), Bangalore, India
Point of Contact: Vivek V. Govilkar, vivek.govilkar@iflexsolutions.com
Maturity Level: 4
Date of Appraisal: Dec 1995
Lead Assessor(s): Ken Dymond

i-flex solutions limited (formerly Citicorp Information Technology Industries Limited aka CITIL), Mumbai, India
Point of Contact: Vivek Govilkar, vivek.govilkar@citicorp.com
Maturity Level: 4
Date of Appraisal: Dec 1995
Lead Assessor(s): Cindi Wise, Ken Dymond

i-flex solutions limited Data Warehouse Center of Excellence, Bangalore, India
Point of Contact: Vivek V. Govilkar, vivek.govilkar@iflexsolutions.com
Maturity Level: 5
Date of Appraisal: Nov 1999
Lead Assessor(s): Ken Dymond, Santhanakrishnan Srinivasan, Anand Kumar

i-flex solutions limited IT Services Division, Bangalore, India
Point of Contact: Anand Kumar, anand.kumar@iflexsolutions.com
Maturity Level: 5
Date of Appraisal: Dec 2000
Lead Assessor(s): Santhanakrishnan Srinivasan, Anand Kumar

i-flex solutions limited IT Services Division, Mumbai, India
Point of Contact: Anand Kumar, anand.kumar@iflexsolutions.com
Maturity Level: 5
Date of Appraisal: Dec 2000
Lead Assessor(s): Santhanakrishnan Srinivasan, Anand Kumar, Atul Gupta

Information Technology (India) Ltd., Delhi, India
Point of Contact: Madhumita Poddar Sen, madhumitap@itil.com
Maturity Level: 4
Date of Appraisal: April 2000
Lead Assessor(s): Pradeep Udhas

Intelligroup Asia Private Limited, Advanced Development Center, Hyderabad, India
Point of Contact: G.V.S. Sharma, gvs.sharma@intelligroup.co.in
Maturity Level: 5
Date of Appraisal: Oct 2000
Lead Assessor(s): Raghav S. Nandyal, John Harding

ITC Infotech India Limited, Bangalore, India
Point of Contact: Paresh Master, pareshmaster@vsnl.com
Maturity Level: 5
Date of Appraisal: Aug 2000
Lead Assessor(s): Richard Storch

Kshema Technologies Limited, Bangalore, India
Point of Contact: V. Bhaskar, vbhaskar@kshema.com
Maturity Level: 4
Date of Appraisal: March 2001
Lead Assessor(s): Krishnamurthy Kothanda Raman

L & T Information Technology Limited, Chennai, India
Point of Contact: Anil S. Pandit, anil.pandit@vashimail.ltitl.com
Maturity Level: 4
Date of Appraisal: Feb 2000
Lead Assessor(s): V. Kannan

Litton Guidance and Control Systems, Woodland Hills, CA
Point of Contact: Roy Nakahara, nakaharr@littongcs.com
Maturity Level: 4
Date of Appraisal: Dec 1998
Lead Assessor(s): Mark Amaya

Litton/PRC Inc., McLean, VA and Colorado Springs, CO
Point of Contact: Al Pflugrad, pflugrad_al@prc.com
Maturity Level: 5
Date of Appraisal: March 2000 (SCE)
Lead Assessor(s): Joseph Morin (LE)

Lockheed Martin Aeronautics Company (formerly Lockheed Martin Tactical Aircraft Systems - LMTAS), Fort Worth, TX
Point of Contact: Phil Gould, philip.c.gould@lmco.com
Maturity Level: 4
Date of Appraisal: Dec 1999
Lead Assessor(s): Leia Bowers White

Lockheed Martin Air Traffic Management, Rockville, MD
Point of Contact: Jim Sandford, jim.sandford@lmco.com
Maturity Level: 4
Date of Appraisal: Dec 1999
Lead Assessor(s): Carol Granger-Parker, Jeff Facemire

Lockheed Martin Federal Systems, Owego, NY
Point of Contact: Ed Fontenot, ed.fontenot@lmco.com; Warren A. Schwomeyer, warren.schwomeyer@lmco.com
Maturity Level: 5
Date of Appraisal: Dec 1997
Lead Assessor(s): John Travalent, Mary Busby

Lockheed Martin Information Systems, Orlando, FL
Point of Contact: Michael Ziomek, michael.ziomek@lmco.com
Maturity Level: 4
Date of Appraisal: June 2000
Lead Assessor(s): Gene Jorgensen

Lockheed Martin Management & Data Systems, King of Prussia, PA
Point of Contact: M. Lynn Penn, mary.lynn.penn@lmco.com
Maturity Level: 5
Date of Appraisal: Dec 2000
Lead Assessor(s): Andy Felschow, Carol Granger-Parker, Dennis Ring

Lockheed Martin Mission Systems, Gaithersburg, MD
Point of Contact: Paul Weiler, paul.weiler@lmco.com; Al Aldrich, al.aldrich@lmco.com
Maturity Level: 5
Date of Appraisal: Oct 1999 (SCE)
Lead Assessor(s): Paul Byrnes (LA & LE)

Lockheed Martin Naval Electronics & Surveillance Systems, Syracuse, NY
Point of Contact: Peter Barletto, pete.barletto@lmco.com
Maturity Level: 5
Date of Appraisal: Nov 1999
Lead Assessor(s): Carol Granger-Parker, Andy Felschow

Lockheed Martin Naval Electronics & Surveillance Systems, Eagan, MN
Point of Contact: John Travalent, john.travalent@lmco.com
Maturity Level: 4
Date of Appraisal: Oct 1999
Lead Assessor(s): Mary Busby

Lockheed Martin Naval Electronics & Surveillance Systems (formerly Undersea Systems), Manassas, VA
Point of Contact: Dana Roper, dana.roper@lmco.com
Maturity Level: 5
Date of Appraisal: Feb 1999
Lead Assessor(s): Judah Mogilensky, John Travalent, Donald White

Lockheed Martin Naval Electronics & Surveillance Systems, Moorestown, NJ
Point of Contact: Nghia N. Nguyen, nghia.n.nguyen@lmco.com; Jeff Tait, jeffery.a.tait@lmco.com
Maturity Level: 4
Date of Appraisal: Dec 1999
Lead Assessor(s): Kevin Schaan, Kent Johnson, Dennis Ring

Lockheed Martin Space Electronics and Communications Systems (formerly Loral Federal Systems), Manassas, VA
Point of Contact: Dana Roper, dana.roper@lmco.com
Maturity Level: 4
Date of Appraisal: June 1995
Lead Assessor(s): Judah Mogilensky, John Travalent, Chris Manak (I)

Mastek Limited, Mumbai, India
Point of Contact: P. Rajshekharan, rajshekhar@mastek.com
Maturity Level: 5
Date of Appraisal: Sept 2000
Lead Assessor(s): Ron Radice

Motorola Australia Software Centre, Adelaide, Australia
Point of Contact: Peter Dew, pdew@asc.corp.mot.com
Maturity Level: 4
Date of Appraisal: Aug 1997
Lead Assessor(s): John Pellegrin (I)

Motorola China Software Center, Beijing & Nanjing, China
Point of Contact: John Jun'an Yu, johny@sc.mcel.mot.com
Maturity Level: 5
Date of Appraisal: Sept 2000
Lead Assessor(s): Dan Weinberger, Patricia McNair

Motorola India Electronics Ltd. (MIEL), Bangalore, India
Point of Contact: Sarala Ravishankar, sarala@miel.mot.com*Maturity Level*: 5
Date of Appraisal: Nov 1993
Lead Assessor(s): John Pellegrin (I)

Motorola, Asia Pacific Telecom Carrier Solutions Group (TCSG) Applied R&D Center,
        Beijing, China
Point of Contact: Graham Hu, qch1422@email.mot.com
Maturity Level: 5
Date of Appraisal: Dec 2000 (CAF-compliant Motorola QSR Subsystem 10 Software Assessment)
Lead Assessor(s): (Fathi Hakam -- Motorola Assessor)

**Motorola, GSM (Global System for Mobile Communications) Systems Division, Network
        Systems Group,** Arlington Heights, IL
Point of Contact: Barbara Hirsh, hirsh@cig.mot.com
Maturity Level: 5
Date of Appraisal: Oct 1997 (CAF-compliant Motorola QSR Subsystem 10 Software Assessment)
Lead Assessor(s): (Ellen Pickthall -- Motorola Assessor)

NCR Corporation, Teradata Development Division, Massively Parallel Systems, San Diego, CA
Point of Contact: Ron Weidemann, ron.weidemann@sandiegoca.ncr.com
Maturity Level: 4
Date of Appraisal: Oct 1999
Lead Assessor(s): Ron Weidemann

Network Systems and Technologies (P) Ltd, Trivandrum, India
Point of Contact: S K Pillai, skp@nestec.net
Maturity Level: 5
Date of Appraisal: May 2000
Lead Assessor(s): Ron Radice

NIIT Limited, New Delhi, India
Point of Contact: Bhaskar Chavali, BhaskarC@niit.com
Maturity Level: 5
Date of Appraisal: Sept 1999
Lead Assessor(s): Richard Storch

Northrop Grumman Electronic Sensors and Systems Sector (ESSS), Baltimore, MD,
Point of Contact: Eva M. Brandt, eva_m_brandt@md.northgrum.com
Maturity Level: 4
Date of Appraisal: Oct 1999
Lead Assessor(s): John Blyskal

Northrop Gruman, Air Combat Systems, Integrated Systems and Aeronautics Sector, El
Segundo, CA
Point of Contact: Leitha Purcell, purcele@mail.northgrum.com
Maturity Level: 4
Date of Appraisal: Oct 1998
Lead Assessor(s): Don Dortenzo

**Northrop Gruman, Integrated Systems & Aerostructures, AEW & EW Systems (formerly
Surveillance & Battle Management),** Bethpage, NY
Point of Contact: Dennis Carter, cartede@mail.northgrum.com
Maturity Level: 4
Date of Appraisal: Oct 1998
Lead Assessor(s): Andy Felschow

Oracle Software India Limited, India Development Center, Bangalore, India
Point of Contact: Ashish Saigal, asaigal@in.oracle.com
Maturity Level: 4
Date of Appraisal: May 1999
Lead Assessor(s): Pradeep Udhas

**Patni Computer Systems Ltd. (PCS), Mumbai, Navi Mumbai, Pune and Gandhinagar
Facilities,** Mumbai, India
Point of Contact: Sunil Kuwalekar, sunil.kuwalekar@patni.com; N A Nagwekar,
nilendra.nagwekar@patni.com
Maturity Level: 5
Date of Appraisal: Aug 2000
Lead Assessor(s): Pradeep Udhas

Philips Consumer Electronics, Philips Software Centre, Bangalore, India
Point of Contact: Bob Hoekstra, bob.hoekstra@philips.com
Maturity Level: 5
Date of Appraisal: July 2000
Lead Assessor(s): Richard Knudson

Raytheon (formerly Raytheon E-Systems), Garland, TX
Point of Contact: Mary E. Howard, mary_e_howard@raytheon.com
Maturity Level: 4
Date of Appraisal: Dec 1998
Lead Assessor(s): Neil Potter

**Raytheon C3I Fullerton Integrated Systems, Command and Control Systems/Middle East
    Operations,** Fullerton, CA
Point of Contact: Jane A. Moon, jmoon@west.raytheon.com; Janet Bratton,
    jabratton@west.raytheon.com
Maturity Level: 5
Date of Appraisal: Oct 1998
Lead Assessor(s): Paul Byrnes (LA & LE), Jane Moon, Ronald Ulrich, Ivan Flinn, Bruce Duncil (LA
    & LE), Janet Bratton

Raytheon Missile Systems, Software Engineering Center, Tucson, AZ
Point of Contact: Michael D. Scott, mscott1@west.raytheon.com
Maturity Level: 4
Date of Appraisal: Oct 1998
Lead Assessor(s): John Ryskowski, Michael Scott

Raytheon, Electronic Systems, Sensors Engineering, El Segundo, CA
Point of Contact: Paul Curry, pcurry@west.raytheon.com
Maturity Level: 4
Date of Appraisal: Oct 2000
Lead Assessor(s): Janet Bratton, Michael Scott, Ivan Flinn

Satyam Computer Services Ltd, India
Point of Contact: Prabhuu Sinha, prabhuu@satyam.com
Maturity Level: 5
Date of Appraisal: March 1999
Lead Assessor(s): Richard Knudson

Siemens Information Systems Limited (SISL), Software Development Group, Bangalore, India
Point of Contact: T. Kathavarayan, kathavarayan.t@sisl.co.in
Maturity Level: 4
Date of Appraisal: Aug 2000
Lead Assessor(s): Richard Storch

Silverline Technologies Limited, Mumbai, India
Point of Contact: S. Purushotham, sp@silverline.com
Maturity Level: 4
Date of Appraisal: Dec 1999
Lead Assessor(s): V. Kannan

Tata Consultancy Services, Ahmedabad, India
Point of Contact: Gargi Keeni, gkeeni@mumbai.tcs.co.in; Rosemary Hedge, rhedge@ahd.tcs.co.in
Maturity Level: 5
Date of Appraisal: Nov 2000
Lead Assessor(s): Ron Radice, P. Suresh

Tata Consultancy Services, Ambattur, Chennai, India
Point of Contact: Gargi Keeni, gkeeni@mumbai.tcs.co.in
Maturity Level: 5
Date of Appraisal: July 2000
Lead Assessor(s): Ron Radice

Tata Consultancy Services, Bangalore, India
Point of Contact: Gargi Keeni, gkeeni@mumbai.tcs.co.in; Uma Rijhwani,
umarijhwani@blore.tcs.co.in
Maturity Level: 5
Date of Appraisal: Jan 2000
Lead Assessor(s): Ron Radice

Tata Consultancy Services, Calcutta, India
Point of Contact: Gargi Keeni, gkeeni@mumbai.tcs.co.in; Arunava Chandra, achandra@tcscal.co.in
Maturity Level: 5
Date of Appraisal: Jan 2000
Lead Assessor(s): Ron Radice

Tata Consultancy Services, Global Engineering Development Center, Chennai, India
Point of Contact: Gargi Keeni, gkeeni@mumbai.tcs.co.in; M. Mala, mala@wst03.tata.ge.com
Maturity Level: 5
Date of Appraisal: July 2000
Lead Assessor(s): John Harding

Tata Consultancy Services, Gurgaon II, New Delhi, India
Point of Contact: Gargi Keeni, gkeeni@mumbai.tcs.co.in
Maturity Level: 5
Date of Appraisal: Feb 2001
Lead Assessor(s): Ron Radice

Tata Consultancy Services, HP Centre, Chennai, India
Point of Contact: Gargi Keeni, gkeeni@mumbai.tcs.co.in; P. Vasu, pvasu@hp.india.com
Maturity Level: 5
Date of Appraisal: July 1999
Lead Assessor(s): Ron Radice

Tata Consultancy Services, Hyderabad, India
Point of Contact: Gargi Keeni, gkeeni@mumbai.tcs.co.in; N V Jayaramakrishna,
jayaram@hydbad.tcs.co.in
Maturity Level: 5
Date of Appraisal: May 2000
Lead Assessor(s): John Harding, Gargi Keeni

Tata Consultancy Services, Lucknow, India
Point of Contact: Gargi Keeni, gkeeni@mumbai.tcs.co.in; Nirmal Kumar,
          nirmal_kumar@lko.tcs.co.in
Maturity Level: 5
Date of Appraisal: Jan 2000
Lead Assessor(s): John Harding, Radhika Sokhi

Tata Consultancy Services, SEEPZ, Mumbai, India
Point of Contact: Gargi Keeni, gkeeni@mumbai.tcs.co.in; P. Suresh, p.suresh@seepz.tcs.co.in
Maturity Level: 5
Date of Appraisal: Aug 1999
Lead Assessor(s): Ron Radice

Tata Consultancy Services, Shollinganallur, Chennai, India
Point of Contact: Gargi Keeni, gkeeni@mumbai.tcs.co.in; R. Ravishankar,
          rravisha@chennai.tcs.co.in
Maturity Level: 5
Date of Appraisal: Nov 1999
Lead Assessor(s): Ron Radice

Tata Consultancy Services, US West, Chennai, India
Point of Contact: Gargi Keeni, gkeeni@mumbai.tcs.co.in; R. Umasankar, rumasan@uswest.com
Maturity Level: 5
Date of Appraisal: April 1999
Lead Assessor(s): Ron Radice, V. Muralidharan, John Harding

Tata Elxsi Limited, Bangalore, India
Point of Contact: M. Thangarajan, mtr@teil.soft.net
Maturity Level: 4
Date of Appraisal: Aug 1999
Lead Assessor(s): Pradeep Udhas

Telcordia Technologies, Inc., Morristown, NJ
Point of Contact: Bill Pitterman, wpitterm@telcordia.com
Maturity Level: 5
Date of Appraisal: May 1999
Lead Assessor(s): Pat O'Toole, Bill Curtis, Norm Hammock

**U.S. Air Force, Ogden Air Logistics Center, Technology & Industrial Support Directorate,
          Software Engineering Division,** Hill AFB, UT
Point of Contact: Jim Vanfleet, Jim.Vanfleet@Hill.af.mil
Maturity Level: 5
Date of Appraisal: July 1998
Lead Assessor(s): Mark Paulk, Brian Larman, Donna Dunaway, Bonnie Bollinger, Millie Sapp, Mike
          Ballard

U.S. Air Force, Oklahoma City Air Logistics Center, Directorate of Aircraft Management, Software Division, Test Software and Industrial Automation Branches (OC-ALC/LAS), Tinker AFB, OK

Point of Contact: Kelley Butler, kelley.butler@tinker.af.mil
Maturity Level: 4
Date of Appraisal: Nov 1996
Lead Assessor(s): Judah Mogilensky

U.S. Army Aviation & Missile Command, Software Engineering Directorate, Redstone Arsenal, AL

Point of Contact: Jacquelyn Langhout, jackie.langhout@sed.redstone.army.mil
Maturity Level: 4
Date of Appraisal: April 2000
Lead Assessor(s): David Zubrow

U.S. Army, Communications and Electronics Command (CECOM), Software Engineering Center (SEC), Fire Support Software Engineering (Telos), Fort Sill, OK

Point of Contact: Don Couch, couchdc@fssec.army.mil; Phil Sperling, sperlips@fssec.army.mil
Maturity Level: 4
Date of Appraisal: Nov 1997
Lead Assessor(s): Don Couch, David Zubrow

U.S. Navy, F/A-18 Software Development Task Team (SWDTT), Naval Air Warfare Center Weapons Division (NAWCWD), China Lake, CA

Point of Contact: Claire Velicer, velicercm@navair.navy.mil
Maturity Level: 4
Date of Appraisal: Feb 2000
Lead Assessor(s): Tim Olson, Ralph Williams

U.S. Navy, Fleet Material Support Office, Mechanicsburg, PA

Point of Contact: Kathleen D. Chastain, kathleen_chastain@fmso.navy.mil
Maturity Level: 4
Date of Appraisal: Oct 1998
Lead Assessor(s): John Smith, Ann Roberts

United Space Alliance, Space Shuttle Onboard Software Project, Houston, TX

Point of Contact: Julie Barnard, julie.r.barnard@usahq.unitedspacealliance.com
Maturity Level: 5
Date of Appraisal: Nov 1989 (SCE)
Lead Assessor(s): Donald Sova (before LA and LE programs)

Wipro GE Medical Systems, Bangalore, India

Point of Contact: K. Puhazhendi, k.puhazhendi@geind.ge.com
Maturity Level: 5
Date of Appraisal: Jan 1999
Lead Assessor(s): Richard Knudson, C. Rama Rao

Wipro Technologies, Enterprise Solutions Division, Bangalore, India
Point of Contact: T. V. Subbarao, subbarao.tangirala@wipro.com
Maturity Level: 5
Date of Appraisal: Dec 1998
Lead Assessor(s): Richard Storch

Wipro Technologies, Global R & D (formerly Technology Solutions), Bangalore, India
Point of Contact: V. Subramanyam, vsm@wipinfo.soft.net
Maturity Level: 5
Date of Appraisal: June 1999
Lead Assessor(s): Richard Knudson, Mark Paulk

Zensar Technologies Limited (formerly International Computers India Limited), Pune,India
Point of Contact: Ashok Sontakke, a.r.sontakke@icil.co.in
Maturity Level: 5
Date of Appraisal: Feb 1999
Lead Assessor(s): Richard Knudson

Appendix B: Instructions for the 2001 High Maturity Survey

The first three sections of the survey contained questions about practices that are sometimes followed in high maturity software organizations. The following definitions were used to describe how often the practices are used in the respondent's organization.

Standardized (Std) — The practice is institutionalized as part of the organization's standard software process. The practice is expected to be followed whenever an opportunity for its effective use arises. Instances where it is not followed are rare exceptions, e.g., in legacy systems or when customer requirements dictate the use of other practices.

Common use (Comm) — The practice is followed frequently, or even in almost all instances when it is appropriate. But it cannot be considered as an institutionalized, standard operating practice in the organization.

Not typically used (NoUse) — The practice is <u>not</u> typically used throughout the organization. It may be used infrequently, perhaps under special circumstances, or on an *ad hoc* basis.

Not applicable (NA) — The practice has been judged as being not applicable for the organization.

Don't know (DK) — The respondent was not familiar with the practice or aware of its use in the organization.

No response (NR) — No answer to this question was provided by the respondent.

Appendix C: Survey Section I –
Management Practices

I.1   **First of all, how are the following management practices used in your software organization? (Please select one for each)**

| I.1 Management Practices	Std	Comm	NoUse	NA	DK	NR
Parametric cost models (e.g., COCOMO, Price-S, SLIM)	23	16	20	1	0	0
Delphi methods for estimation	19	18	22	1	0	0
Critical chain (e.g., theory of constraints)	4	14	33	2	5	2
Earned value	24	9	25	1	1	0
Personal Software Process^{SM}(PSP^{SM}) and/or Team Software Process^{SM}(TSP^{SM})	1	6	48	4	1	0
Integrated product & process development (IPPD) (a.k.a., concurrent or simultaneous engineering)	12	18	22	6	1	1
Chief architect / chief engineer	26	11	17	2	4	0
Independent SQA group	57	0	3	0	0	0
SQA function embedded in process (.e.g., a role in the peer review method, via buddy system, or as Software Configuration Management entry criteria for baselining)	49	6	3	2	0	0
Incremental or evolutionary life cycles (e.g., JAD, RAD, spiral development, rapid prototype)	35	19	6	0	0	0
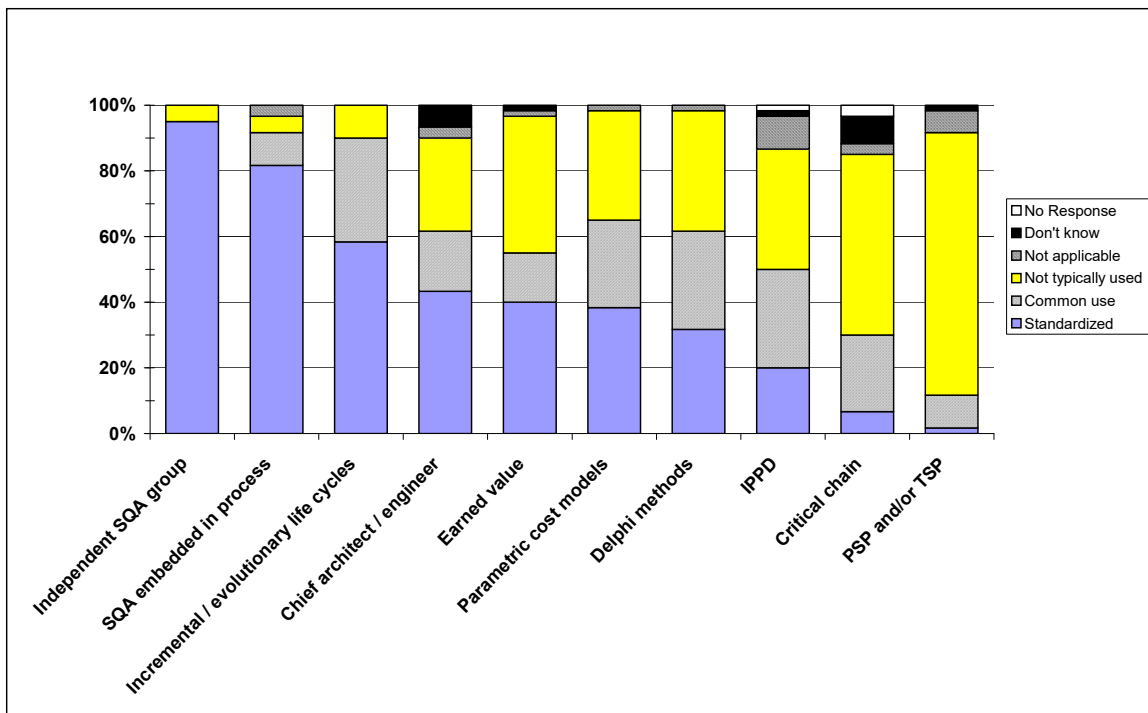
Figure 2 Management Practices

I.2   Has your organization rejected these or any other management practices for common or standardized use? (Please describe any such practices here, along with your reasons for rejecting them.)

Because of the diversity of the workload many management practices and tools have evolved to support customers and our business practices. We have attempted to develop common tools and methods across the organization, have not always need successful. Time has seemed to bring tools, methods, and practices to a common point.

CG-Smith (CGS) follows its own proprietary model called Uniphase. Uniphase is the life cycle model, which is followed at CGS. Uniphase is composed of four basic elements: the process, the screen, the store, and Management and Control (M&C). The Uniphase recognizes software development as a value-added activity. The Uniphase assumes that the products that are produced during a software development project are valuable and ensures that the products have achieved the required level of value before storing the product to guard against losing its value.

- Process – The process element defines the transformation activities of the Uniphase.
- Screen – The screen element identifies the techniques that verify and validate products produced by the Process elements.
- Store – The store element identifies the input and output products of the software process element as well as their source and destination. It configures, manages and controls the software products produced by the process element.

- Management & Control (M&C) – M&C elements identify the resources and the mechanisms required to monitor and control the process, screen and store elements within the Uniphase. It describes the measurements to be taken and the reports to be generated, as well as identification of all responsible persons for managing the Uniphase.

COCOMO estimation was found to be overly complex to be productively and efficiently used on a per-release basis (i.e., the effort dedicated to input and calculate the estimation was found to have minimal ROI).

COCOMO never gained the confidence of our organization; people feel they do a more accurate job of estimating with internally developed spreadsheets.

Critical chain is used extensively on our hardware/manufacturing side. We need to learn some for software. Our process group is pushing PSP/TSP, but we are having difficulty gaining acceptance. Always a question of ROI.

Critical chain, earned value, TSP, and PSP are not rejected as such. They are being debated internally to adopt or look for alternatives. IPPD does not fit into our business model. Chief Architect – though NIIT has a pool of architects who are designing solutions, this role is gradually emerging.

Earned value is being considered. Currently, we have equivalent indicators being monitored. PSP, TSP, and IPPD are part of our long-term plan and will be implemented at a later date.

Estimation guideline is based on FP and LOC modified to suit organization's requirement. Inability to bring in commonality for newer technologies.

Function Points and Feature Points were found not suitable for our environment.

I am not familiar with the term "critical chain" but interpreted it as critical path and responded based on this interpretation. We have investigated PSP and TSP but are not pursuing them currently due to time and cost considerations.

Independent SQA group approach was thought of, but having SQAs from within project teams with a dotted line reporting to the Quality Manager was found more suitable for the organization's culture.

No, we re-consider them periodically, usually at the initial project phases, when the tailoring of the process for the project needs is defined. We have not yet reached a general decision regarding those methods that are not typically used, we decide for each project separately.

No. The organizational tailoring guidelines take care of the variation needed at process and task levels.

None of these have been rejected.

Not in system integration business now.

Off-the-hat estimation.

Organization has an internally developed cost model based on 30 years of experience. Organization is now beginning to investigate use of parametric cost models as the new upgrades show characteristics aligned with industry cost models, and diverging from organization's historical norms.

Our company is very large with hundred organizations so it is very common to have many practices being used somewhere that may not be visible at corporate level. However, many practices are standardized by corporate via policies and they are verified by SQA and internal audit.

PSP and TSP were rejected because the benefits did not outweigh the costs.

PSP and Six Sigma methodology were initiated, and now we are focusing on standardizing Design for Six Sigma methodology for improving both product and process quality.

PSP/TSP. Though not rejected, we evaluated official training courses and found them to be very expensive. Instead, we found collaborative software development and adaptive software development and other agile methodologies like Extreme Programming, etc., to be easier to practice and provide more overall benefit, albeit numerically the individual programmer does not get a benchmark to compete.

Rejected independent SQA Group. Standardized SQA function embedded into the program.

SLIM.

Sometimes, we have rejected strict life cycle models and allowed projects to evolve a model and then take to the QS.

Standardized Six Sigma principles in SQM, QPM, DP, PCM, and TCM.

They have not rejected them, but for now they do not add any business value to the organization.

We have not rejected any practice forever! Practices are regularly piloted, evaluated, adapted and built into the process documents incrementally.

We haven't rejected anything. We just find that some are more suitable for us to use than others.

Appendix D: Survey Section II – Engineering Practices

II.1   How are the following engineering practices used in your software organization? (Please select one for each.)

| II.1 Engineering Practices	Std	Comm	NoUse	NA	DK	NR
Domain specific software architectures	26	30	4	0	0	0
Product lines or product families	21	25	7	7	0	0
Other systematic reuse (i.e., characterized by an organizational strategy for reuse)	13	29	11	2	1	4
Quality function deployment (QFD)	8	14	30	3	4	1
User interface prototyping	16	38	5	1	0	0
Independent test groups (i.e., independent of the developers of the software system)	37	13	8	1	0	1
Code coverage (e.g., path or branch)	23	27	9	1	0	0
Defect prediction, reliability, or release readiness models (e.g., Goel-Okumoto model, basic execution time model)	25	13	22	0	0	0
Formal methods (e.g., proof of correctness)	16	10	29	2	3	0
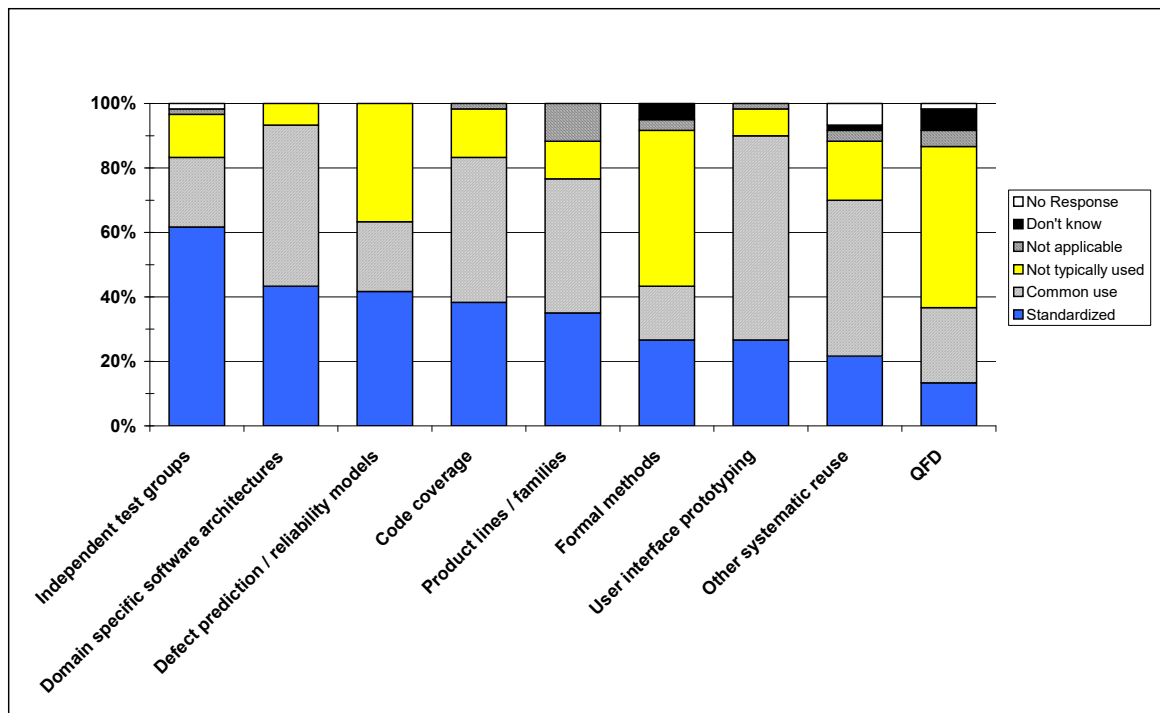
Figure 3 Engineering Practices

Other systematic reuse (i.e., characterized by an organizational strategy for reuse) (Please describe briefly here)

A reuse library has been created which is available on line for all the engineers. Further, the project plan will contain the details regarding the reuse items planned to use for the project and also the reuse items planned to be generated at the end of the project, which will get into the reuse repository.

As of now, there isn't any organizational strategy for reuse.

Catalogued reuse libraries.

Certain systemic reuse is in place: template for certain life cycle phases and certain methodology, requirement change forms etc. Code reuse repository exists for many languages and domains.

Common development environments are widely used for different technology platforms. The process framework, QMO, also specifies reuse analysis as one of the required steps.

Common platforms, application libraries, and standardized product lines (with incremental changes between versions) enable reuse. Standardized use of requirements break up and

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flowdown, standardized use of score cards for quantifying, measuring, analyzing capability, predicting and tracking "Critical to Quality" requirements.

Commonality across product lines.

Componentware group and database are in place. Project information, internal tools/systems, knowledge repository and many other databases are available to everyone in the organization.

COTS (reuse) first initiative – gearing people with selection tools / population tools / estimation tools for use.

Depending on the contract and agreements with the client, some projects have a strong emphasis on reuse, including project-specific goals for reusability of components and the amount of reuse.

DII COE.

Each software development project plan has a mandatory section on reuse, forcing the manager to identify the effort reduction that will be made through reuse of existing artifacts.

For some engagements of specific clients, we could even have a common process and follow similar practices – sometimes reusing several components across the projects. The only difference could be the team and the schedule.

In one product line, we practice strategic code reuse.

Object-oriented methods that allow for and enhance reuse.

Organization has been developing software baselines and significant upgrades for 30 years. To date, software products, such as source code and test procedures, are used whenever feasible.

Process Assets Library is maintained as a repository of projects executed. This is used in new projects.

Project-wise learnings are reused. Knowledge management initiative across the organization, which focuses on technology reuse, is under progress.

Repository based reuse of components.

Research into developing a product line requirements engineering environment to establish requirement and associated objects reuse has not yet been satisfactorily proven as cost effective.

Reusable components established and designed for use across applications in O-O environment

Reuse asset library exists. Usage is standardized. The organizational strategy mandates build / design for reuse.

Reuse is by domain champions, who remember where it is and how it can be re used.

Reuse of existing designs applied to similar products.

Reuse of the tools, process, process assets are identified in the start-up phase of the project and is encouraged.

Reuse planning is a part of the organization's standard process for project planning. An organization-wide tool is implemented to facilitate storage, search and retrieval of reusable components.

Tata Infotech has a dedicated initiative for promoting the building, maintaining, and using of re-usable software components and tools. We have built a repository of reusable components, which are commonly used in building the software solutions.

Technology specific – classes, libraries, Web-based components, testing strategy, etc.

The best practice in-house tools are identified and made available for reuse and provided infrastructure support and mandated for consideration at start time.

The code is reused in certain long-term projects where the customer is same.

The organization has access to various repositories of reusable components, but their use is limited. Most reuse is done based on follow-on work and where reuse of existing components (design, etc.) was bid in the proposal.

There are two kinds of reuse, one is project-level, second one is organization-level reuse. Project-level reuse is widely used in our organization. Organization-level reuse is studied, practiced here.

This is being tried out in specific domains like eCommerce. Not yet widely prevalent.

Use of standards, checklist and functions through repository.

We follow a set of documented processes which denote typical reuse philosophy, from the establishment and maintenance of a repository to the access, monitor, and use by the workforce.

We have a separate function which focuses on design and architectural reuse.

We have created an organization level Process Database to encourage reuse.

II.2 **Has your organization rejected these or any other engineering practices for common or standardized use? (Please describe any such practices here, along with your reasons for rejecting them.)**

Formal methods have been researched and found to be restricted to a limited set of applications and do not scale up well.

Formal methods were rejected after piloting due to dependence on externally generated requirements and inadequate requirements specification notation.

I wouldn't say that they have been rejected, they are just not commonly used. We are learning more about reliability and actually are doing some IRAD studies in this area.

No. All are followed always.

No. The organizational tailoring guidelines take care of the variation needed at process and task levels.

None are rejected. The understanding exists, however, that a practice has not been standardized.

None of these has been rejected.

QFD is not used because our customer base is well known.

QFD is part of our future plan. We will consider this at a later date.

Same as in the management case – we were not able to make a general decision in our analyses for any of the methods that are designated as "Not Typically Used." The decision was made either on a project basis or (in the case of user interface prototyping) because of product management and organizational restrictions.

The above engineering practices have not been rejected.

The formal methods, such as proof of correctness, have not been officially rejected, however the organization relies more on peer reviews for "proof".

We have not rejected any practice forever! Practices are regularly piloted, evaluated, adapted, and built into the process documents incrementally.

Workload diversity coupled with a large customer base has made it difficult to become standardized. Within the individual product lines, we see more common-use practices.

II.3   **What kinds of peer review activities on work products are done in your organization? (Please select one for each)**

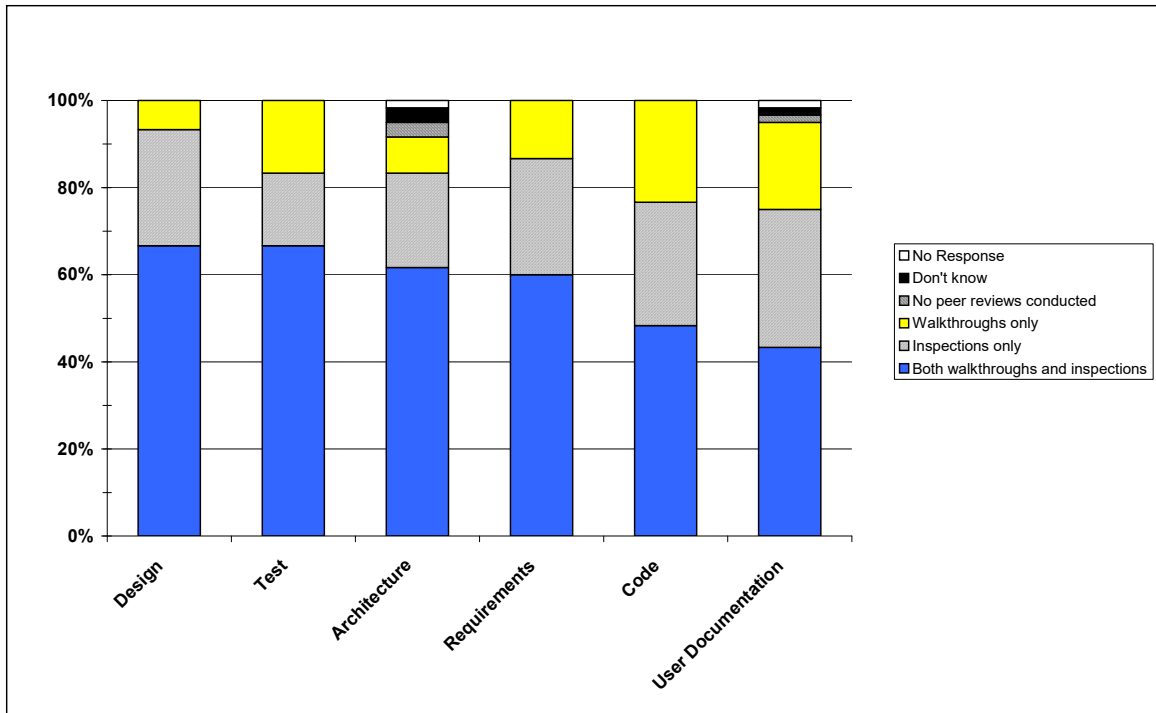| II.3 Peer Reviews	Both walkthroughs and inspections	Inspections only	Walkthroughs only	No peer reviews conducted	DK	NR
Requirements	36	16	8	0	0	0
Architecture	37	13	5	2	2	1
Design	40	16	4	0	0	0
Code	29	17	14	0	0	0
Test (e.g., test cases, plans, or procedures)	40	10	10	0	0	0
User Documentation (e.g., operator's manuals, installation notes, online help)	26	19	12	1	1	1

Figure 4 Peer Review Practices

Appendix D: Survey Section III – Quantitative Analysis

III.1 **How are the following quantitative analysis practices used in your software organization? (Please select one for each.)**

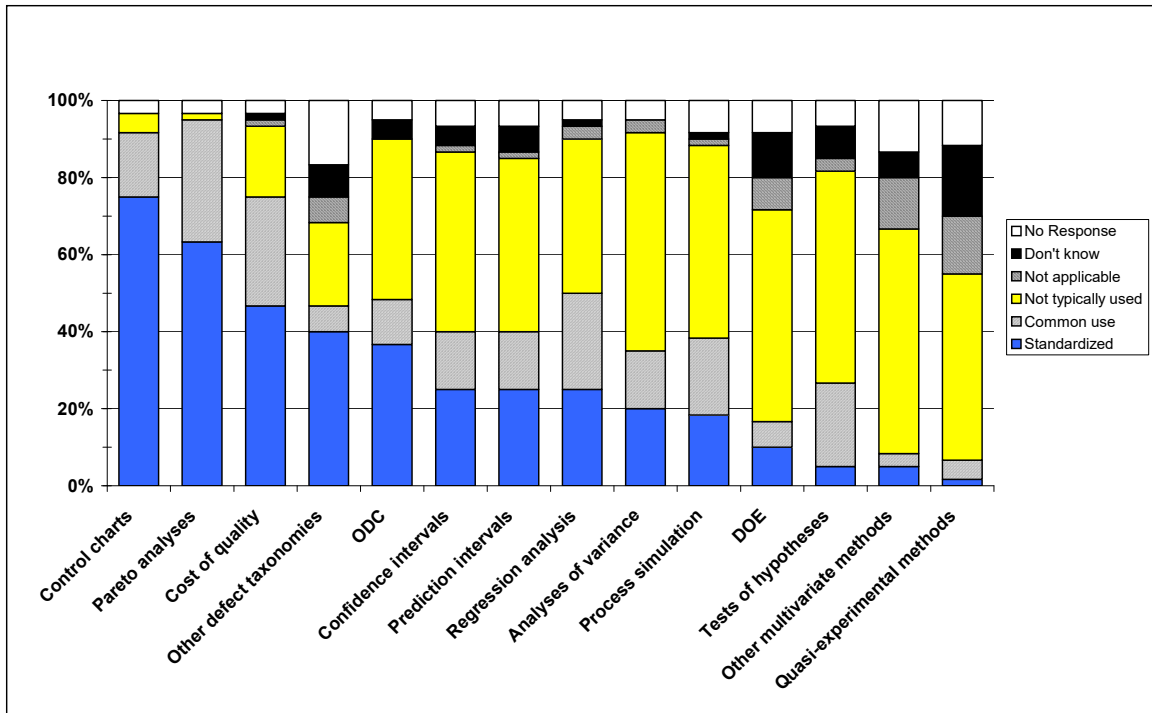| III.1 Quantitative Analysis Practices	Std	Comm	NoUse	NA	DK	NR
Cost of quality analysis	28	17	11	1	1	2
Orthogonal defect classification (ODC)	22	7	25	0	3	3
Other defect taxonomies	24	4	13	4	5	10
Control charts (e.g., XbarR, XmR, u)	45	10	3	0	0	2
Confidence intervals	15	9	28	1	3	4
Prediction intervals	15	9	27	1	4	4
Regression analysis	15	15	24	2	1	3
Tests of hypotheses	3	13	33	2	5	4
Designed experiments (DOE)	6	4	33	5	7	5
Quasi-experimental methods	1	3	29	9	11	7
Pareto analyses	38	19	1	0	0	2
Analyses of variance (e.g., ANOVA, ANCOVA, MANOVA)						
Other multivariate methods	3	2	35	8	4	8
Process modeling or simulation (e.g., system dynamics models, or spreadsheet based "what if" studies of process performance and impact analyses)	11	12	30	1	1	5

Figure 5 Quantitative Analysis Practices

Other defect taxonomies (Please describe briefly here)

Classification according to type, severity, and cause.

Classification of defects based on severity, phase at which injected, and phase at which detected.

Defects are categorized based on severity and further classified into different types (e.g., logical, lack of clarity, interface, etc.).

Defect detection rates based upon test procedures and worked lines of code.

Defect measures like DIR (defect injection rate), DDR (defect detection rate), DDE (defect detection effectiveness), defect leakage metrics from phase to phase.

Defect tracking statistical charts.

Defects are categorized into major and minor, where major is defined as those that would result in failure of the executable product. Root cause analysis is performed on major defect trends.

Defects are classified as per types and severity; age is also calculated.

Defects are classified as per type, severity, and origin.

Defects are classified in review / testing protocols.

Error injection model.

Historical company classification; defect severity and defect cause.

I was not sure what you are referring to in "cost of quality analysis".

In-house defect classification systems and definitions.

In-house defined defect taxonomy based on historical data.

Internal taxonomies.

Internally developed taxonomies, customer specific.

Organizational defect database is widely used. In-house developed procedures for causal analysis and categorization of defects have been standardized. Pareto techniques and Ishikawa method are widely used.

Our own method, which includes root cause analysis, defects origin analysis, severity analysis, etc.

Root cause analysis.

Service requests with severity levels.

Severity classification and identification of originating phase are mandatory.

Standardized defect categories defined according to life cycle phase.

We have developed defect prevention database system (DBDS) for internal use, which is based on statistics methodology.

Control charts (e.g., XbarR, XmR, u) (Please describe briefly here)

At organizational level, control charts are used for deriving metrics norms for all parameters. Few projects use control charts for quantitative analysis

Bar graphs.

Being expanded across all projects now. Is now a mandatory tool in project management.

Both XbarR and XmR charts are used at the organization level.

CGS uses control charts.

Control charts are used to determine capability of the organization's projects to meet cost, schedule, and quality performance measures.

Control chart technique is used. Standard deviation is always compared with the mean for lower and upper control limits selection. Generally, sigma is maintained around 10% of the mean. Moving window technique is used for estimating the PCB at project and organization levels in order to estimate the performance of the current process.

Control charts used on walkthroughs: defect density, walkthrough rates, and walkthrough effectiveness.

Most commonly used are: XbarR, XbarS, u-chart, and p-chart.

Mostly XmR, with some XbarR.

Several u-charts, primarily with performance of the testing process.

Standardized on XmR. Occasionally u-charts are also used.

The weighted lateness process expands on the X-bar chart concept to include historical and categorized control limits.

These are used for organization-wise metric baseline reports to share process capabilities and help project managers do estimation, and set project goals.

u- and Z-charts for process and product metrics.

u-charts, p-charts.

u-charts, Z-charts, XmR.

u-charts and XmR charts.

UCL / LCL for dispersions, Pareto charts, normal distribution of effort / schedule deviations.

Used for cost / schedule control.

We mostly use Xbar and u-charts.

We predominately use the u type of control chart with increasing use of the XbarR chart to examine other attributes of processes.

We use XbarR charts.

XbarR.

XbarR, u-charts; sometimes c-charts.

XbarR, XmR.

XbarR, XmR, pi.

XbarR, XmR.

XmR.

XmR charts are used to determine process capability for project specific software process and the UCL and LCL derived are used to monitor the project-specific software process quantitatively.

XmR charts primarily – used for defection detection and inspections.

XMR, u-charts.

XmR, u-charts.

Designed experiments (DOE) (Please describe briefly here)

For new technology, designed experiments are carried out by Technology Research Council.

Pilot evaluation.

Piloting using SPC and control charts.

Prototyping is commonly used within each product line.

Some of the projects that use DMADV Six Sigma methodology use DOE methods.

Test of hypotheses and designed experiments are being used in the pilots where Six Sigma is used.

Training is occurring for designed experiments: planned for organization rollout through 2002.

Up to three factor, full factorial DOE.

Web-based tool built-in for internal assessment, with questionnaire from each KPA, and analysis done at project and organization level to take corrective action.

Quasi-experimental methods (Please describe briefly here)

Piloting in live projects to measure quantitative benefits.

Using queuing models to predict arrival rate for production problems in maintenance projects.

Other multivariate methods (Please describe briefly here)

Graphical tools such as box plots and matrix plots.

Ishikawa diagram.

Process modeling or simulation (e.g., system dynamics models, or spreadsheet based "what if" studies of process performance and impact analyses)

"V" and incremental model is widely use here.

CGS uses proprietary process development methodology. Dynamic modeling, impact analysis, and prediction based on current process behavior are part of it.

Crystal Ball, Promodel, other in-house.

Research into using process modeling and simulation of the standard process has been prototyped, but the use of the models to perform prediction has yet to be applied due to the fidelity limitations of the simulation to actual project experience.

Spreadsheet-based analysis of process change impact. We don't usually predict new process performance, because we have doubts regarding the validity of the prediction models that we

know for this purpose. We try new processes on a small experimental scale and then compare with our ordinary process using our standard performance parameters.

System dynamic models and simulation are carried out for examining the system performance, process performance, and understanding the requirements.

Use of System Architect and BPWin for modeling baseline – process certification is formalized.

What-if analyses.

What-if analysis of proposed methodologies.

III.2   In which life cycle phases, if any, are control charts used in your organization? (Please select one for each)

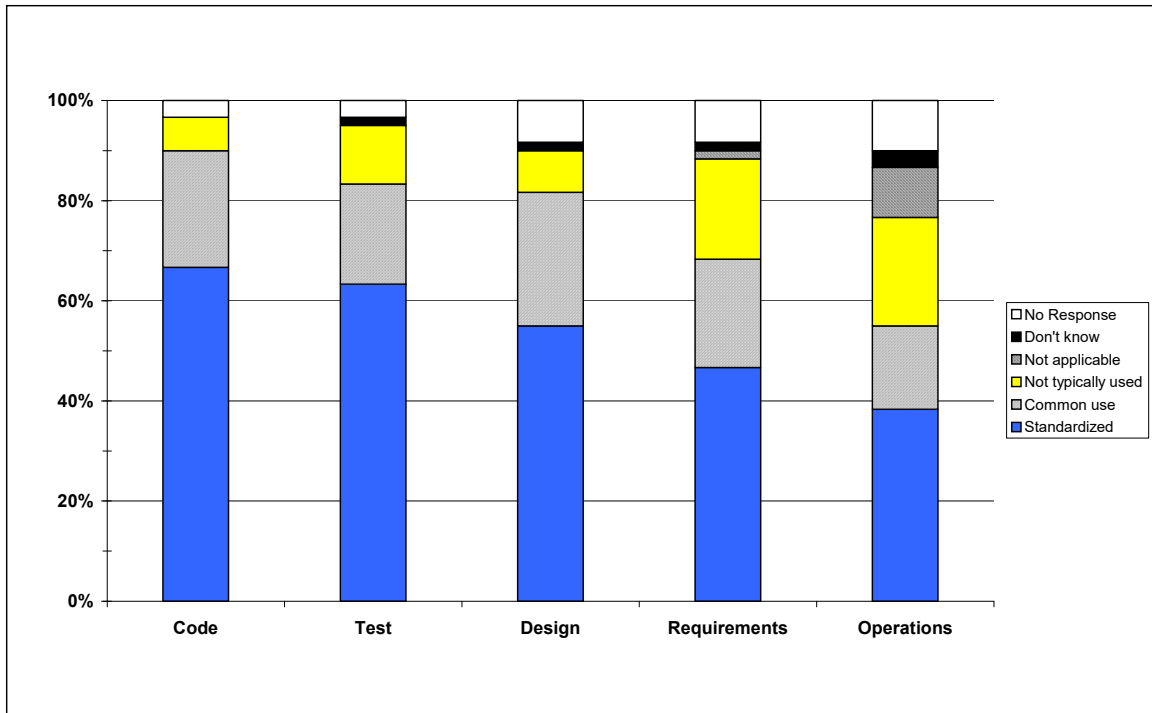| III.2 Control Charts	Std	Comm	NoUse	NA	DK	NR
Requirements	28	13	12	1	1	5
Design	33	16	5	0	1	5
Code	40	14	4	0	0	2
Test	38	12	7	0	1	2
Operations	23	10	13	6	2	6

Figure 6 Control Chart Practices Across Life Cycle Phases

III.3   What kinds of quality and performance measures are used in your software organization? (Please select one for each)

III.2 Control Charts	Std	Comm	NoUse	NA	DK	NR
Cost performance	46	9	3	0	0	2
Schedule performance	57	1	0	0	0	2
Requirements stability (e.g., number of customer change requests or clarifications)	41	12	5	0	0	2
Process stability (e.g., number of changes or waivers from defined development processes)	37	16	3	0	1	3
Rework	36	14	8	0	0	2
Staff morale (e.g., climate surveys)	24	18	14	0	2	2
Defect measures (e.g., from inspections and reviews, test results, other trouble reports, or field defect	57	1	0	0	0	2

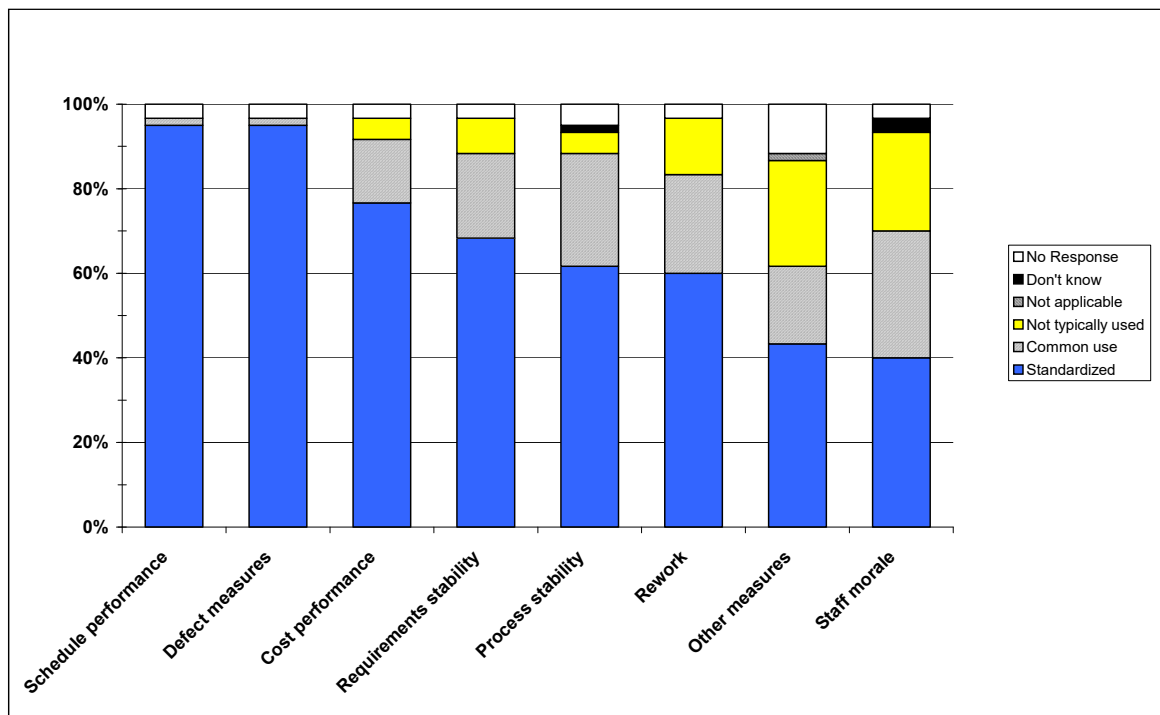| III.2 Control Charts	Std	Comm	NoUse	NA	DK	NR
reports)						
Other quality, capability, or performance measures (e.g., mean time to failure, maintainability, interoperability, portability, usability, reliability, complexity, reusability, product performance, durability, employee certification)	26	11	15	1	0	7

Figure 7 Quality and Performance Measures

Defect measures (e.g., from inspections and reviews, test results, other trouble reports, or field defect reports) (Please describe briefly here)

All of the ones you defined above.

Applied on walkthroughs and trouble reports.

Automated defect reports from all peer reviews and testing. Defect analysis through Pareto charts, fish bone analysis.

CGS has developed an integrated process tool called iC2™, which is totally automated. One of the modules of this tool is a defect management module, which helps in recording, tracking, analyzing, and defect prevention activities.

Collect data from inspections, peer reviews, product sell-offs, and customer trouble reports.

Defect densities during system testing and acceptance testing are measured for all software projects.

Defect densities in documents and code (as uncovered by inspections and testing). Also post-release reports from customers.

Defect density, defect removal efficiency, quality improvement index, and phase containment index.

Defect density, inspection effectiveness.

Defect detection – profile through life cycle phases.

Defect detection is being done during reviews and testing. The following measures are standardized:

- review efficiency
- defect removal efficiency (in process)
- overall defect density
- defect distribution

Defect insertion rates and defect removal rates from the various phases of the development cycle.

Defects are gathered both in process and when fielded.

Defects in products are collected starting with peer reviews of requirements, problem reports in testing, and continues with (some) field defect reports.

Defects obtained from reviews, inspections, walkthrough, testing, and customer reported. Defect injection rate, defect removal efficiency, review efficiency, testing efficiency, etc., are measured and used.

Defects tracked for life of system (end-to-end) from product development through operational use and beyond.

Defects, types, category, severity, defect origin, defect density, defect distribution, etc.

Defects / hour, defects / KESS, defect density by severity category.

For each product delivered (2.5-2.7M SLOC), 70-80% of the product is reused from previous products, so we have a lot of defect data applicable to the reused code which is used to continually define reused code and strategies. Also use defect data from inspections / reviews. Numbers and types of defects (categories) are collected from inspections, and defects from delivered products.

From inspections, testing, reviews (internal and external), user acceptance tests.

In-process faults, in-process defects, PCE, PSE.

Inspections of design, code, and trouble reports from test.

Inspections, reviews and tests, acceptance and warranty defects.

Inspections: containment; faults sourced to phase. Test: plan vs. executed; coverage. Release defects: backlog; arrival rate.

Internal Defects Analysis, Reporting and Tracking System (DARTS).

IPD (in-process defect), defect containment effectiveness, post-release defects.

Major and minor defects are grouped as operational and pre-operational to determine the defect removal effectiveness of the process.

Measurements for internally detected defects (reviews, inspections, etc.) and externally detected defects (client PRs, etc.). Number of defects, severity, distribution, defect-free deliveries, rework effort, etc.

Most of these are standardized in the organization.

Phase-wise and program (overall) slip ratios. Traceability, test coverage, and code coverage. State-wise (new, assigned, open, resolved, and verified) and severity-wise (from 1 high to 4 low) defects analysis / tracking. Separation of in-process and post-delivery defects.

Review and test defects for all phases of the applicable life cycle are collected and analyzed. Defects are also classified as pre-ship and post-shipped defects. Quality targets for each milestone are set based on previous performance.

Review per life cycle phases, SQA reviews, SEPG process reviews, test group reviews, customer / user reviews, and acceptance test.

Reviews and test defects are classified according to ODC and analyzed.

The defects data are used for causal analysis (Pareto, fishbone diagrams) and in control charting to identify root causes and take defect prevention activities. Defect classification is standardized across the organization.

We use defect measures both from internal efforts (inspections, etc.) and from customer feedback / field reports. All data are used for defect prediction and process / product development.

We use the following parameters for defect measures: for inspections and walkthroughs: defect density per size (according to document type, number of reviewers, review effort). For test or field detected defects: arrival and closure rates, defect age, defect backlog – according to severity, by release and functional area or subsystem. In addition, classification by defect type (e.g. usability) and root cause.

Other quality, capability, or performance measures (e.g., mean time to failure, maintainability, interoperability, portability, usability, reliability, complexity, reusability, product performance, durability, employee certification) (Please describe briefly here)

Availability.

Availability (99.999 % availability).

Balanced Score Card is used at project, group and organization levels.

Classified requirements. (Templates.) Checklists for every work product. Process and product metrics such as subsystem and functional quality measurements, reliability measurements, etc.

Complexity, reusability, maintainability, customer satisfaction.

Customer satisfaction surveys, CPARs, technical performance measurements.

Employees are assigned process roles; with training and experience, they achieve management certification of their ability to perform on projects.

Functionality, efficiency and maintainability characteristics and associated sub-characteristics are measured and used for decision making during product delivery to the client.

Maintainability is a big issue with such heavy reuse, we automate and have several tools that must run with no errors to verify maintainability. Note: reuse is built into our local cost model and is not measured independently in this organization.

Maintainability, stability, and performance are evaluated. There is no uniform measure across all lines of business.

Mean time to failure is used during maintenance phase of the project. Other measures such as interoperability, portability etc. are used based on customer-specific quality requirements.

Mean time to failure, customer ticket opening arrival, closure, age and root cause – per release, effort, and schedule performance per feature and per phase, phase containment effectiveness, review effectiveness (by defect density compared to effort), skill mapping and training effectiveness, effort distribution by tasks, work task breakdown plan effectiveness (effort actual vs. plan performance vs. goal and UCL / LCL range).

Mean time to failure, maintainability, interoperability, portability, usability, and reliability are measured.

Measures like maintainability, reliability, reusability, level of reuse, etc.

Most of these are standardized in the organization.

MTBF is monitored for the performance of network and system support functions

MTBF, number of failures.

MTTF is collected / analyzed by the Customer Support BU. Product performance is part of Performance Plan developed at project level.

MTTF.

MTTF, availability is the number one, usability, reliability, complexity, performance.

MTTF, MTTR.

Performance measures like maintainability, interoperability, portability, reliability, etc., will be identified in the project plan wherever it is applicable. It is measured and analyzed based on that.

Portability and reliability in some cases.

Process conformance, critical item performance, productivity analysis.

Product performance in terms of CPU throughput and memory utilization.

Product performance, complexity, usability, maintainability.

Productivity, percent reuse, time to correct P/CRs.

Reliability and complexity are used in proposal cost / schedule estimates.

Reliability and MTBF.

Reuse ratio (planned / actual), ESLOC performance ratios.

Run time , cost and schedule averaging (sliding windows), defect density, defect detection ratio.

Schedule variance, effort variance, rework effort, defect density are some of the measures standardized across organization.

We are practicing with some measures of functionality especially around reliability.

We have developed a software reliability growth model, which is based on the development processes in use in the organization. This provides an early look at the predicted delivered quality of the product.

Will be tracked as part of requirement since we work in project mode.

III.4 **Does your organization have a centralized measurement program? (Please select one)**

No	2
Yes	50
No response	8

In what year was it formalized?
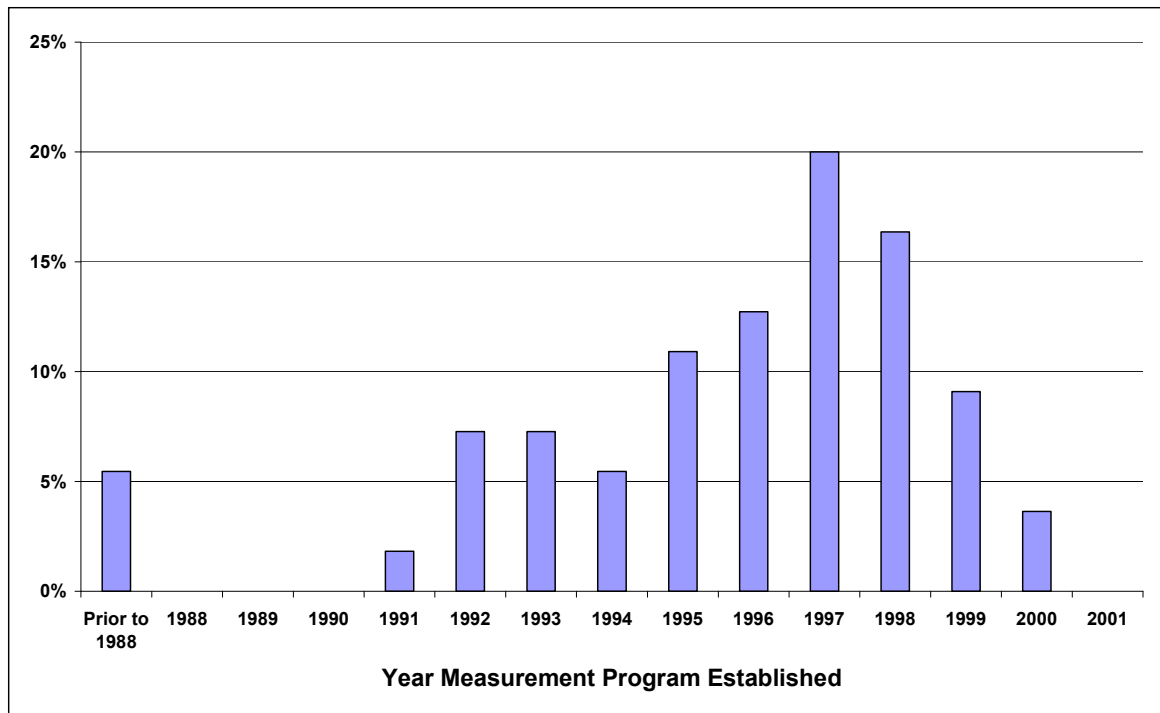
Figure 8 Year Centralized Measurement Program Established

III.5   Which of the following best describes how the software measurement and analysis effort is staffed in your organization? (Please select one)

An organization-wide measurement or metrics group	18
Measurement is the responsibility of the SEPG or Quality Assurance	14
Separate groups or individuals for different projects or other organizational units	12
Other	9
No response	7
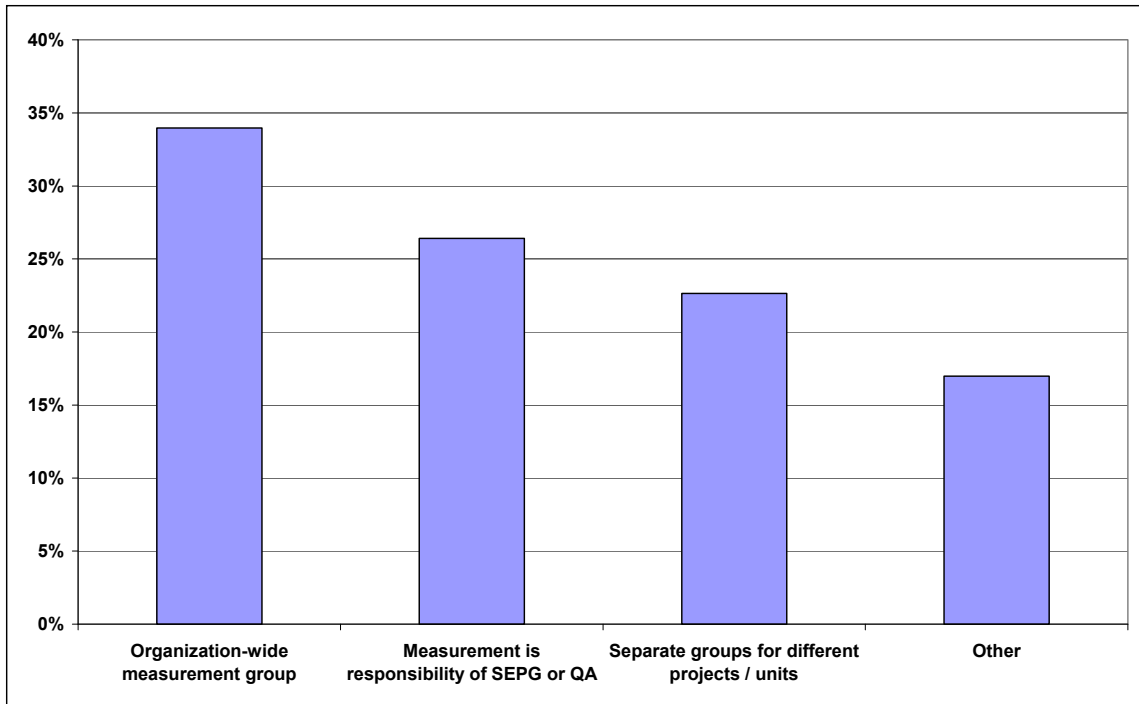
Figure 9 Staffing of Measurement Program

Separate Groups or Individuals for Different Projects or Other Organizational Units (Please describe briefly)

Analysis effort is split between various managers with responsibilities in the areas of the metrics assigned to them.

Analysis is done at project, group and organizational level. At different levels persons involved in Quality Assurance typically are responsible for the analysis.

At project level, PM/PL is made responsible.

At project level, project manager and quality coordinator are responsible for metrics analysis. SQA group also will do the analysis and present in the monthly quality council meetings for senior management review in respective business units

Centralized measurement system is made available and the measurements and analysis are owned and done by the project team. Independent quality team facilitates them.

Corporate SEPG advocates measurement via a measurement program. Division and organization SEPG implement and collect data. SQA verify data collected and used.

Each product-line manages the software measurement and analysis effort. They in turn provide data to the organization for organizational rolls ups, which is managed by the SEPG.

Each project team has an SQA rep who collects metrics. The centralized quality group collects customer satisfaction scores.

Measurement and analysis is performed within the product lines. The SEPG captures, analyzes, and maintains the information.

Measurements at two levels: 1) Organizational level – these relate to organizational goals. Measurements are defined and each project gathers them; and they are collated by SEPG at organization level and analyzed on a quarterly basis. 2) Project level – these relate to project specific goals and may include other goals, besides the organizational ones. Measurements are taken and analyzed on a continuous basis by the project manager.

Metrics coordinators throughout organization.

Project software leads, SEPG, and other organizational units (e.g., SQA, finance, data management, etc.) have data collection and analysis responsibilities.

Projects have project metrics coordinator responsible for project measurement and analysis. PMC sends project data to organization metrics manager who does org level measurement and analysis. OMM is part of Integrated Process Group.

Responsibility for measurements and analysis at project level is with respective projects. Consolidation of project data at organizational and analysis of the same is with SEPG.

SEPG coordinates.

Software measurement and analysis is distributed throughout the organization. Measurements are collected and analyzed as appropriate at various levels and by functional areas. The metrics coordinator delivers required data to the client. A metrics group, in coordination with the process group, performs additional analysis.

Some large projects have a dedicated person to handle measurements and analysis.

There is an independent group SETC, software engineering and technology center, responsible for process improvement, quality assurance, new technology introduction, tool management and support, software engineering training. SETC leads the org wide measurement program, all project development involved in the program.

We have deployed quality facilitators in projects to do this task.

We have standards for the metrics, but each project has individuals that are looking at their specific data.

Other (Please describe briefly)

All projects do their own recording, and analysis as they need. In addition, the measurement group analyzes data at corporate level or helps projects also in specific analysis.

Each program measures its own quantified achievements vs. goals. At org level, these measurements are rolled up and analyzed for variance against org level goals.

Each project has metrics contacts to collect / report data into an organization-wide metrics database, supported by an organization-wide metrics group. The system generates common reports, quarterly metrics reports by products and by BU within the org. Projects / BUs may also have product / BU-specific metrics specialists.

Each project tracks and reports data and there is a metrics focal point for the organization who analyzes and archives.

Every group there is a person responsible for measurement activities, which are controlled by a central metrics group, part of SEPG.

Every support function head also captures the measurements, and performance is monitored using the related metrics.

Measurement is the responsibility of project people, quality assurance, and SEPG. Data entry and reports automated through tools and reviewed by PM, SQA, SEPG and senior management.

Measurements are a natural outcome of process execution and get recorded in a central repository at each center. In addition to the project level analysis, the SEPG / QAG use this data for analysis at the center level too. This data / findings later get consolidated at the corporate level.

Metrics collection automated. Project teams do analysis. Organization-wide metrics consolidated and analyzed by SEPG.

Project groups or individuals collect and analyze project metrics. SEPG collects metrics from projects and does organizational analysis and reporting.

Software measurement and analysis efforts are split among various groups depending on the measurements and the analysis being performed.

There is an organization-wide metrics group to serve org level needs. Each project has a process engineer to serve measurement needs of project as well.

To some extent - ALL of the above are done.

III.6   Approximately how much of your organization's quantitatively managed information is supported using automated tools? (Please specify a number for each area)

% ... Data collection (e.g., on-line forms with ""tickler"" reminders, time stamped activity logs, static or dynamic analyses of call graphs or run-time behavior, tools for data integrity, verification, and validation)
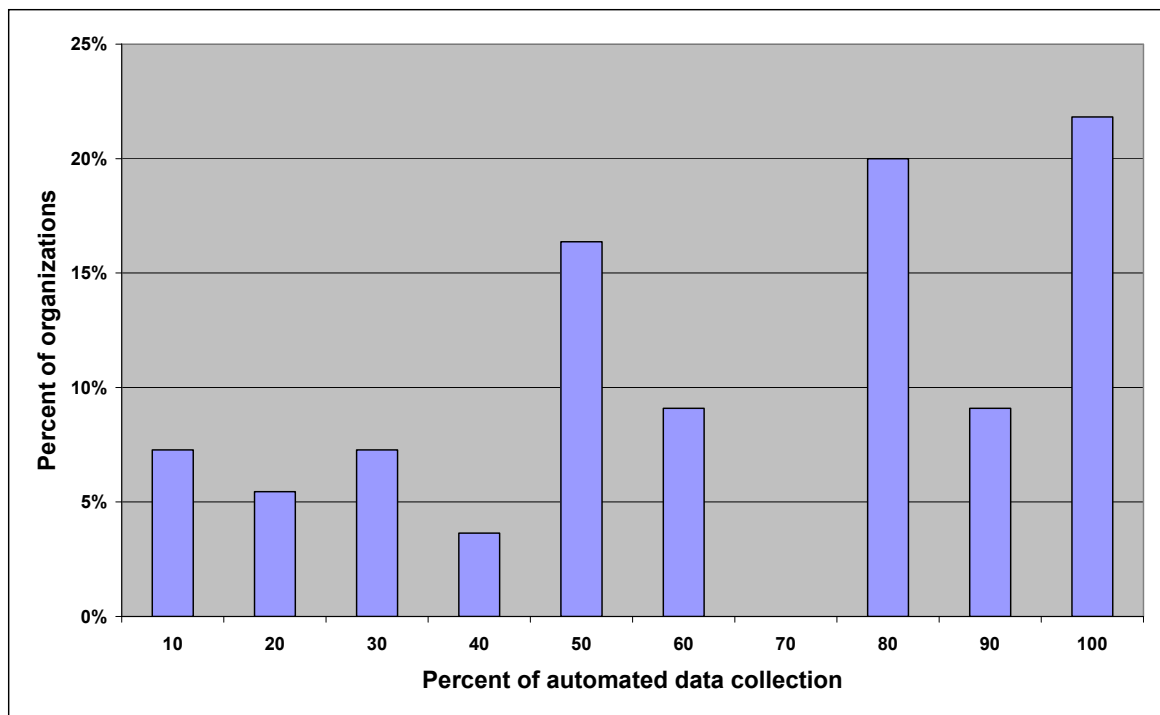
Figure 10 Data Collection Using Automated Tools

% ... Data analysis and report preparation (e.g., spreadsheets, statistical, graphing, and report presentation packages)
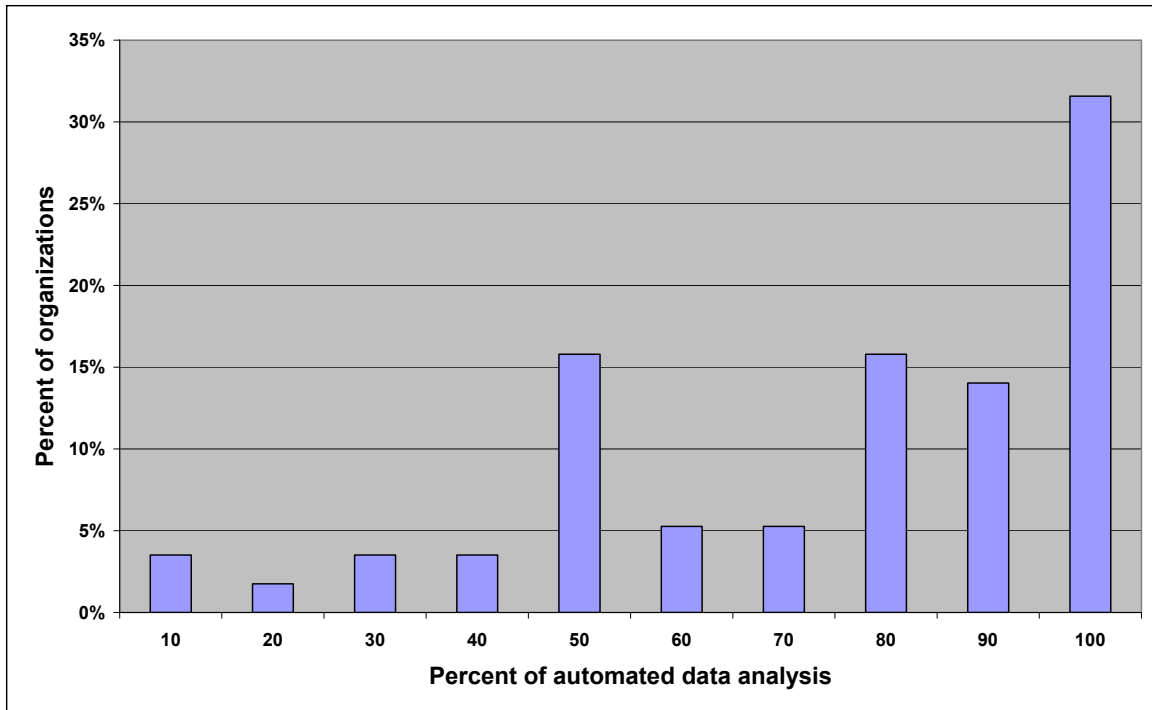
Figure 11 Data Analysis and Report Preparation Using Automated Tools

III.7   How has your decision making behavior changed as a result of your quantitative and statistical practices? (Please describe change here)

1. Changes in process, more confidence in trying new procedures. 2. More accurate decisions for project plan updates. 3. A much enhanced prediction capability for project performance. 4. Enhanced focus on opportunities for improvement – at the project, organization and process levels

A causal analysis meeting when any of the critical parameters goes above the limit. Every group releases a report, which is authenticated by all the affected groups.

Able to improve estimation. Able to decrease deviations on effort and schedules (ensuring that they are within benchmark limits). Rework has reduced due to improvement in testing and reviews. Development process has improved.

All changes in the organization are now based on systematic analysis of past experiences, backed up by quantitative data.

All management reviews and decisions are based on the quantitative analysis report on the tracking of the projects.

Based much more on hard facts and numerical data than gut feel across the project's software leads.

Because of good quantitative and statistical practices, CG-Smith is in a better position to manage projects effectively and more predictably.

Considerably on a few programs; marginally on others.

Data is used to make decisions rather then knee jerk reactions based on crisis.

Data-centric.

Decision making is strongly backed by data.

Decisions are more data driven rather than intuitive. There are still internal debates about the usefulness and appropriateness of SPC.

Deviations from released quality goals are known 4-6 months in advance of release. Preventive / corrective actions routinely taken. Schedule variance well understood. "Mega projects" routinely ship on time.

Estimation methods have changed significantly. We refine estimation parameters based on quantitative and statistical analysis. We also give customers valuable inputs on when to schedule enhancement in a maintenance projects based on production fix arrival analysis.

Goal setting, estimation and tracking, COQ are quantitatively done across the company.

Improved insight into the project activities, enabling more timely and informed decisions.

It provides greater visibility, with the facility to be able to drill down and find the real root causes. This provides better control and the ability to take quicker, fact-based decisions to solve problems. It also provides early warning for potential problems, which can be tackled proactively, before they really occur. And most important, it saves management time, besides providing all these benefits!

Management is now expecting predictive analysis from the project leads. They are wanting to know what they can expect as the project progresses.

Managers are more prone to base decisions and presentations to higher management on data rather than on opinion. Opinion-based decision-making is not absent, but more frequently substantiated by facts and data.

Managers are using outputs, trends, etc., to make decisions and key on problem areas.

Metrics-based PMO, process improvement based on SPC analysis.

Metrics has improved the predictability. Metrics is shared with the team and they are made part of the decision making.

More in process management using data. Focus on defect prevention. ROI way of life to make decisions.

More reliant on using data (and sometimes questioning the validity of the data) to make decisions.

Most of the decisions are data driven.

Mostly decisions now made based on quantitative analysis. This has also resulted in process improvements at the both the organization and project level

NCs frequency triggers process relook. Code review checklist improved. Estimation enhanced for customer resource loading. Estimation model refined. Modules prone to errors, putting PM attention. Study of factors affecting the effort on fixing defects.

Not much.

Organizational baseline is used to plan expected performance .It is helpful in estimating effort, planning review time, estimating review defects, planning code walkthrough time, and estimating code walkthrough defects, estimating test defects.

Prior to the implementation of organization wide metrics program, most of the decisions were taken based on project managers experience and feel for the project. With the implementation of organization wide metrics program and introduction of automated project management tools, projects decisions are more objective in nature and there is lot of transparency in data and decision making process.

Process parameters and their measurement are used for taking decisions.

Quantitative management is an early warning system. Cost, schedule, and final product quality (defect density) has improved up to 78%.

Senior management bases all decisions and goal achievement on quantitative data. Drastic change when actions are given from the top.

Senior managers review is always based on the metrics analysis report. This has helped in increasing the phenomenal support from practitioners due to improved visibility, reduced cost

of failure, continuous process improvement, increased customer satisfaction level and enhanced satisfaction to the practitioners.

Statistical and particularly control charts have helped to see the "forest," allowing ready identification of aberrant trees. Some techniques have enabled more rapid response (e.g., SPI / CPI monthly) where previous cumulative average review had the effect of smoothing variations inappropriately.

The analyzed data is being used in PES meetings (phase decision meetings)

The application of W / L fosters a better understanding and use of schedules as a management tool, and helps develop "trust" of numbers and their use as an integral part of management/control. Defect and test charts played an important role in developing the entrance and exit criteria for testing (can't enter testing without having one; test is not complete if the charts do not say so).

The metrics has become the most important input in all reviews and decision making process.

There has been a major change in this area. Decisions are based on the analyzed data. This has also helped us in reducing the time required to take any decisions.

These practices may have changed the decision, but the decision making behavior has not changed.

Very much. Every manager and team leader takes decisions based only on data and its analysis. Decisions are reviewed for their stability and risk. (p values, etc.) Measurements are tracked via control charts.

We are asking different kinds of questions, seeking the engineer's perspective more often, and generally being more proactive.

We now determine the capability of projects to perform and to establish expected performance goals based on observed measurements.

Went back to put in more efforts to improve the accuracy of data through increased awareness and more standardized practices.

When data become information (analyzed and compiled), management does act and change to some degree. It is a cultural thing.

Yes. All discussion and debate now draws on numbers collected and disseminated.

Yes, we are data driven now, where it was management driven before.

Yes, we are purely business oriented, our decision is made based on our metrics.

Yes, we have become less reactive and we are producing more accurate plans that reflect true project performance, e.g. holidays, vacation, winter weather, etc.

Yes. The guys can now make decisions based on actual data rather than feelings.

Yes. We are able to take good and fast decisions. Bad interpretation is also curtailed and tips are given in analysis.

Yes. More proactive, easy identification of potential problems. Timely resolution of the same. Better risk management.

Appendix E: Survey Section IV – Process Management

IV.1   **Approximately, how many process elements or requirements do you have in your organization's standard software process (or set of standard processes)?**
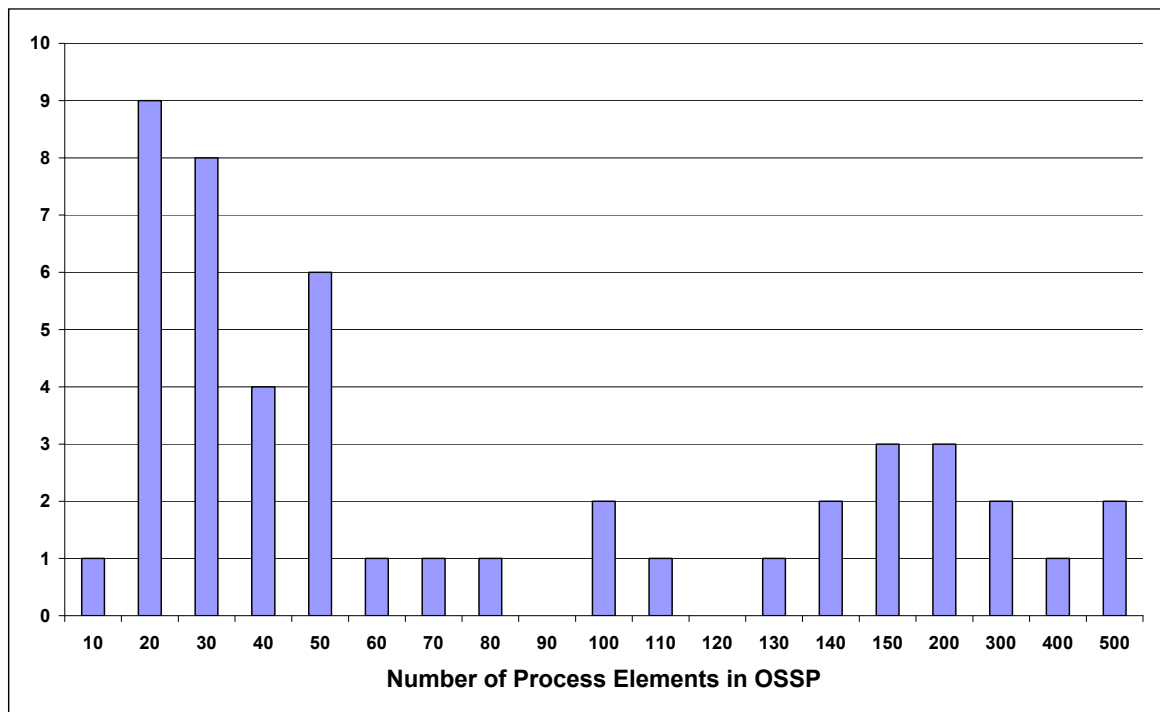

Figure 12 Number of Process Elements in OSSP

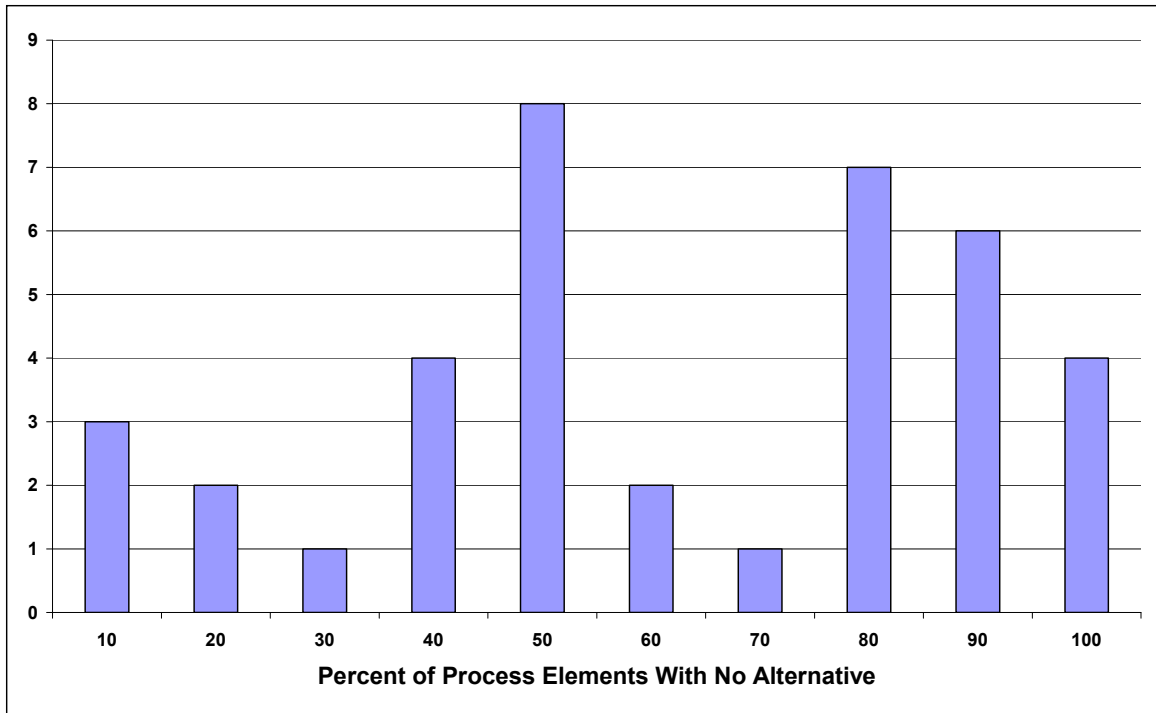**% of these elements having no alternatives that can be used in their place**

Figure 13 Percent of Process Elements With No Alternative

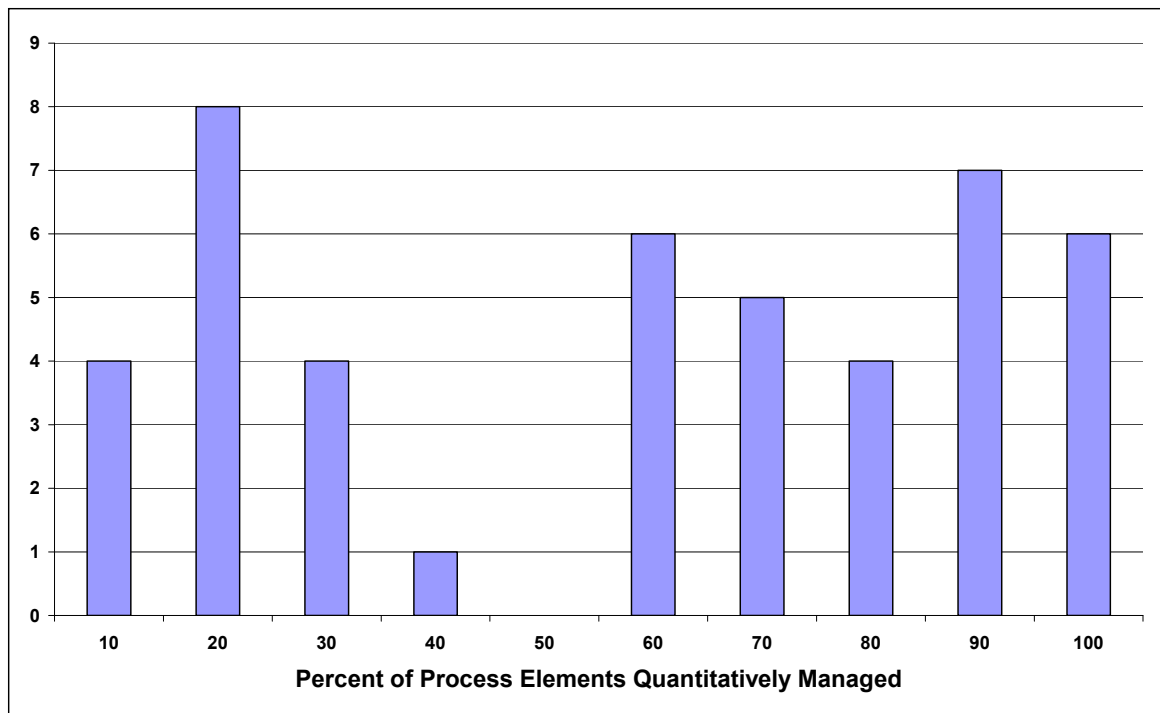**% of the elements within the set of standard processes that are quantitatively managed**

Figure 14 Percent of Process Elements Quantitatively Managed

Table 4 Process Elements

IV.1 Process Elements	Number of Process Elements	Percent of Elements with No Alternative	Percent of Elements Quantitatively Managed
N	48	38	45
Average	95	60	57
Median	48	60	60
Maximum	500	100	100
Minimum	10	10	5
Standard Deviation	113	28	32

IV.2   Approximately, how many software process improvement proposals do you receive annually?
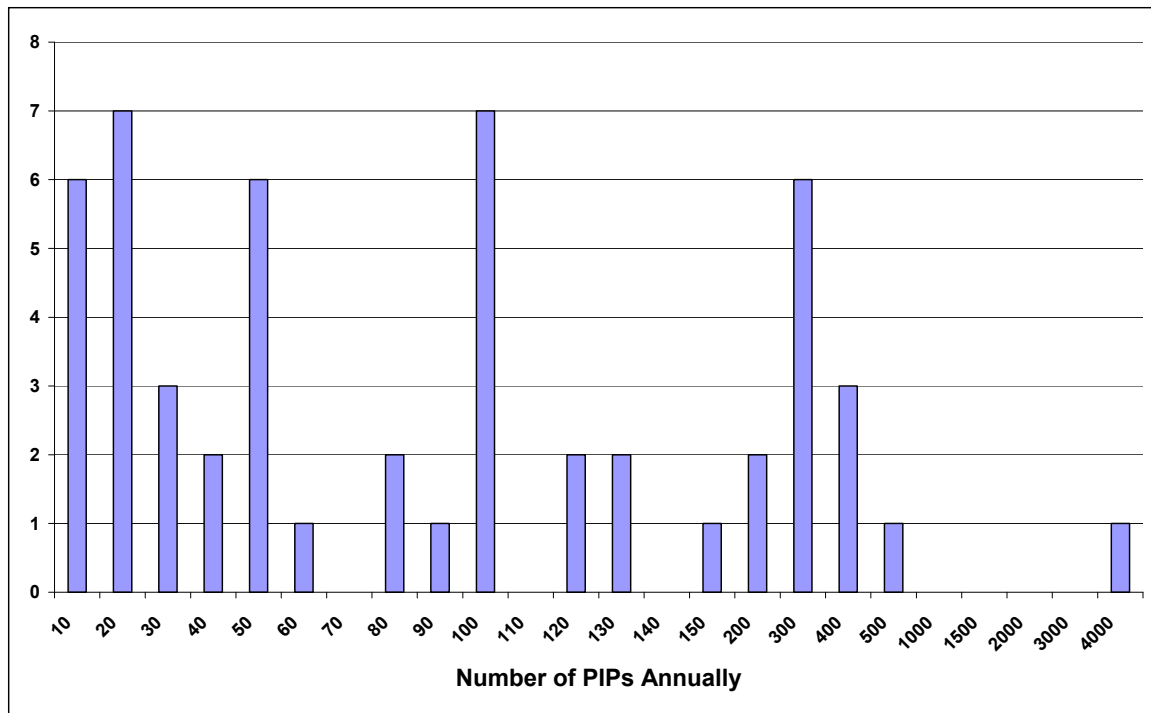

Figure 15 Number of PIPs Annually

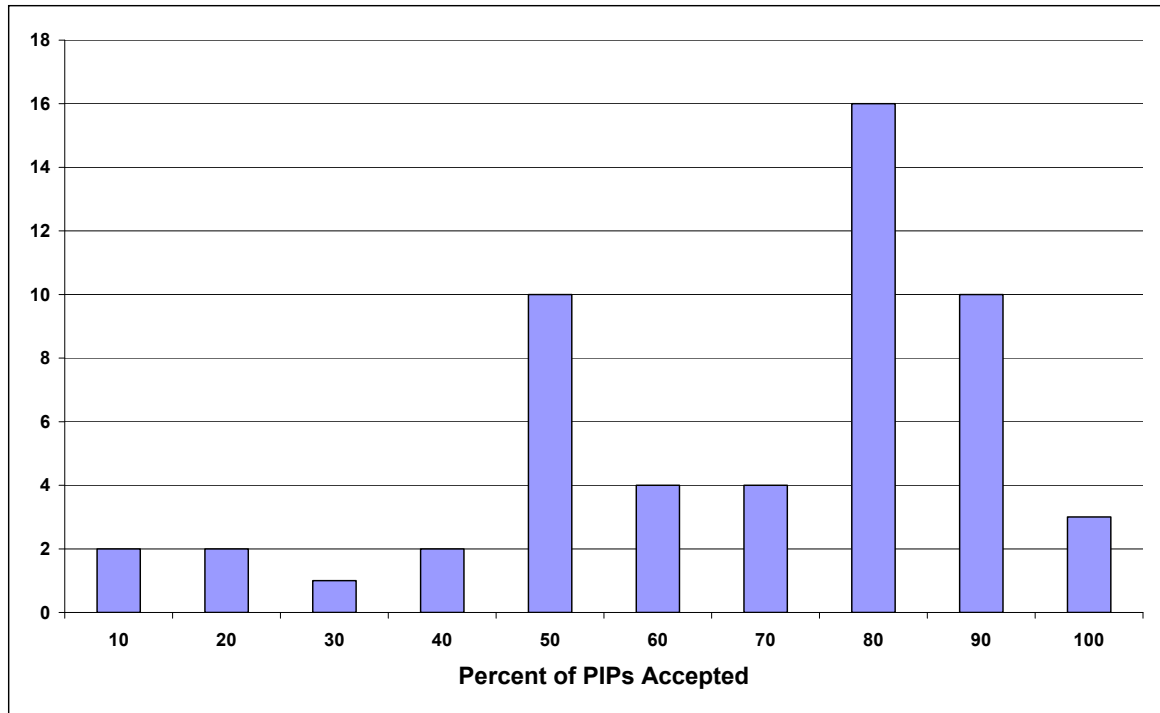**% . of these proposals that are accepted**

Figure 16 Percent of PIPs Accepted

IV.3   How often are these practices followed in your organization? (Please select one for each)

IV.3 Process Definition Practices	Almost always	More often than not	Less often than usual	Rarely if ever	NR
Process descriptions are less than three pages	21	16	10	10	2
Process owners exist who have specific accountability to management	47	7	2	2	1
The organization's standard software process is pre-tailored at the organizational level for different purposes (e.g., product lines, application domains, or customer segments)	33	10	11	4	1

IV.3 Process Definition Practices	Almost always	More often than not	Less often than usual	Rarely if ever	NR
Each distinct process is defined separately, with few dependencies on other processes	25	16	9	8	1
Procedures and checklists describe specific task concepts (e.g., design implementations, estimation procedures, or baselines)	49	8	1	0	1

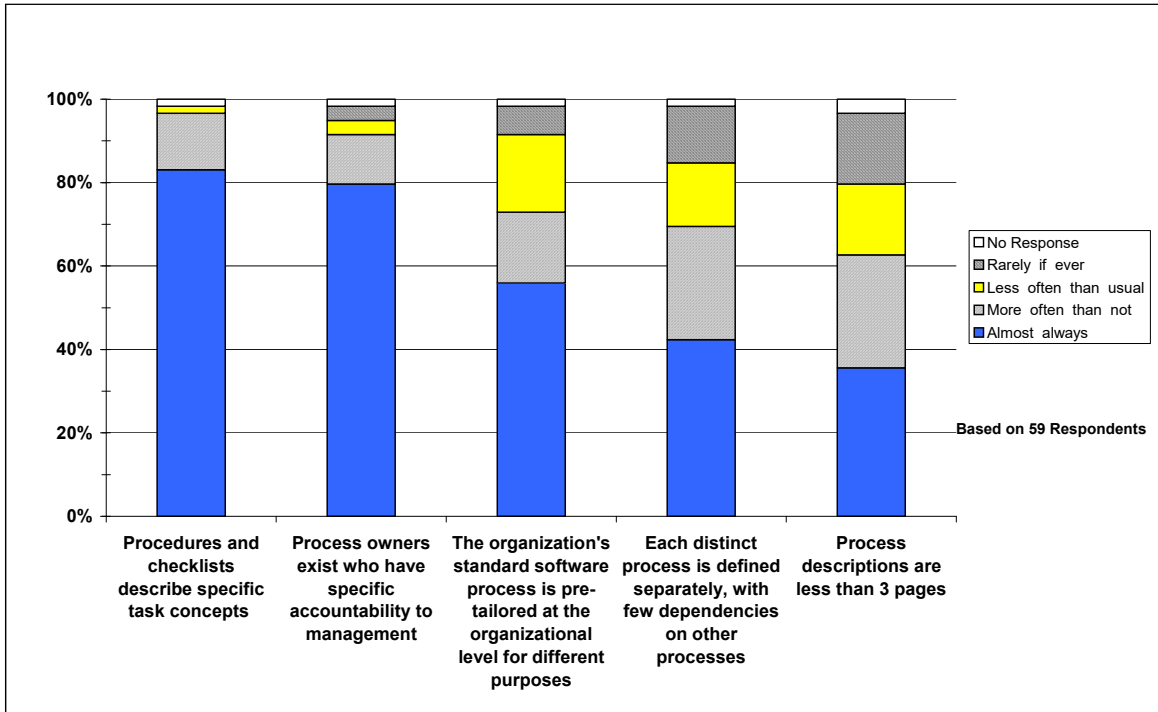*Figure 17 Process Definition Practices*

IV.4 **What process notations are used in your software organization? (Please select as many as apply)**

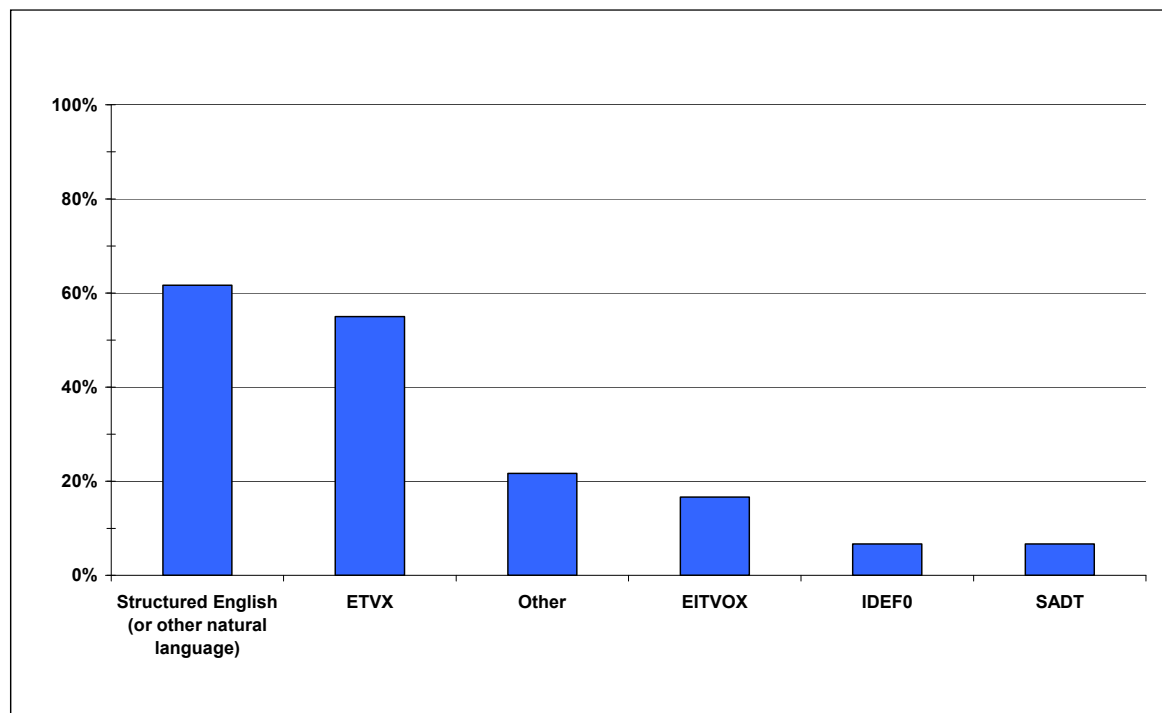|	
ETVX	33
EITVOX	10
IDEF0	4
SADT	4
Structured English (or other natural language)	37
Other	13

Figure 18 Process Notations Used

Other (Please describe briefly here)

A variant of ETVX with more structured English built in, including description on purpose, responsibility, predecessor / successor, entrance / exit criteria, steps / tasks, any documents/metrics required, etc.

Block diagrams, tables, charts etc., using Microsoft Office Suite.

CGS has a proprietary methodology of representing the process elements i.e., SPN (Structure Process Notation): SPN identifies the relationship among the activities within the process element, its relationship with other process elements, its relationship with the customer, and the technical reviews of the product or products.

Combination of the above.

Cross-functional process maps.

Each process has roles activities inputs outputs.

ETVXM.

Flow charts.

Flowchart. Template extension on ETVS.

Follow a standard template with a required structure.

It is having the contents of ETVX, not the exact format.

Standard processes are written in normal prose using an outline checklist form to enhance usability.

Use Visio to support process modeling.

We have a tabular format with "smart" icons, which essentially captures the ETVX notation and also has some additional enhancements.

We have recently settled on a new manner of structuring our process documents. This is likely to remain stable for the foreseeable future.

We use ETVMRX (Entry, Task, Verification, Measurement, Responsibility, eXit) and English.

IV.5   Has your organization rejected these or any other process management practices for common or standardized use? (Please describe any such practices here, along with your reasons for rejecting them)

No… except tailoring for customers with equivalent practice.

No, we have not considered any other process notation method than the one we use so far, we have not realized the need.

Not sure what this is asking? We rejected IDEF0 because it was too complicated, it became the focus, not the process.

We have found English to be most appropriate for end user process descriptions.

We have recently settled on a new manner of structuring our process documents. This is likely to remain stable for the foreseeable future. We have not evaluated every possible notation but chosen the first that meets our needs.

We have not rejected anything. We just find that some are more suitable for us to use than others.

We originally considered EVTX but decided against it. We may be moving toward implementing it in the near future as we update our process elements.

Yes, for example, subcontract process from other Motorola organization is not applicable in Motorola China, we have to update it according to local law and regulations.

IV.6   What, if any, process management practices that may prove to be important for performance excellence are currently being piloted in your organization? (Please describe them here)

1. A flexible lifecycle model tailored from RAD. 2. Making metrics report part of group managers monthly report (for global operations).

Automated metrics collection, Web-based process documents (including templates and checklists), online workflow application for logging, tracking, and closing audit findings, novel development methodologies.

Balanced score card, CMMI.

CMMI.

Cost models, allocation models, estimation techniques for maintenance projects.

Customer managed projects process metrics for full support projects (enhance, corrective, production support).

Earned value; DOE.

EDa (an orthogonal defect analysis process), prediction models.

Extreme Programming and adaptive software development.

Formal process certification.

Independent Verification & Validation, PSP.

Knowledge management system at corporate level for improving the business.

Lean with Six Sigma.

Lightweight software development processes, iterative and prototype based processes.

Moving towards CMMI approach with integrating best practices from software, systems, and hardware engineering communities.

Phil Crosby QIT program is being practiced on regular basis. EFQM was introduced recently and is in a pilot stage.

Presently we are taking process management practices from CMMI, P-CMM and other TQM models for performance excellence.

PSP targeted for this fiscal year.

QITs based on Six Steps to Six Sigma.

Reuse process developed by my org is piloted now.

Rework, defect prevention, process change management.

Short duration projects processes.

Six Sigma.

Six Sigma.

The concept of managing point and checking point is being piloted for performance measurement and improvement of key management functions. The concept of "Deep Analysis" is being applied to identify causes and improvement actions for some of the chronic problem areas.

Use of "Quad Charts" with process stop light indicators, which are reviewed monthly by senior management. An evolution of the GQIM indicator approach, using a variety of quantitative or statistical techniques, as appropriate.

Use of Six Sigma methodology (Six Steps to Six Sigma) for transactional processes and DMADV methodology for design applications.

We are considering a process enactment tool that is part of the suite that has been selected for project management.

We are exploring areas around rework data collection and reporting. We are exploring practices associated with reliability and formalized testing.

We are piloting project management information system software. This is based on our measurement program. We are also piloting some defect tracking tools. We are also piloting role of process mentor, assigned to group of projects.

We have our own homegrown corporate practices.

We have run pilots, however, none are currently ongoing.

We plan to automate the workflow of processes and integrate it with the organizational repository.

Web-based tool for accepting process feedback. Analyzing and tracking the implementation.

Web-based metrics collection and presenting through dial-gauge. Process automation tool. Cost of Quality analysis. Web-based monitoring of SQA activities, including benchmarks. Risk management database. Refining processes for new technologies.

Workflow automation currently being piloted.

IV.7   How does your organization solicit feedback about the usefulness and usability of its process assets?

1. Consolidate findings during internal audit and review. 2. Periodic SEPG forums. 3. Analysis of customer satisfaction survey.

1. Discussion at representative forums with the constant participation of engineers (process and other focus groups, monthly project tracking meetings, quality audits and reviews, QA staff meetings). 2. Measurements and analysis of performance.

1. In-built feedback mechanism in the Process Repository. 2. SEPG home page on the Intranet. 3. Monthly process improvement scheme.

Analysis of hits. Survey. Workshop.

Analyze SDPs and tailoring process. Discussions within the SEPG.

Automated process modification form.

Centralized process change control system accessible to organization.

Change Request and Action Item Systems are available to everyone. Approximately 15% of staff have used these to comment on the process assets.

During project facilitation by SEPG, process improvement proposals.

Event driven - process opportunity request, post-mortems. Periodic - Continuous audits(monthly), assessments (half-yearly), etc.

Every year there is a review of the processes and all the project managers are specially invited to give their inputs. There are week long conferences to discuss these inputs in one of the centers - which is participated from reps from other centers too. This is followed by drafts reviewed and completed as per the responsibilities assigned. Inputs are also sought thru direct feedback mechanism and thru the periodic project reviews, phase end reviews, project end meetings and audits.

Feedback directly to the SEPG is available on-line. Questionnaires. Management reviews (annually/quarter).

Feedback mechanisms are in place to get feedback from users as and when required. Besides in management council meetings the relevance and usefulness of process assets is discussed.

Feedback on web-site; process improvement database.

Formal process improvement recommendation process.

Internal assessment, suggestion box, deviation analysis, project reviews.

Monthly management reviews at project level, training course feedback, quarterly DSEPG/Steering Council sessions.

Monthly quality forums, Intranet mail box, process change requests, process feedback.

Online Quality Helpdesk for logging, assigning, escalating and fixing quality process-related problems, exclusive online discussion group for project managers, SQA rep meetings, online structured questionnaire-based survey of project managers and SQA reps, process evaluation by existing and potential clients.

Our quality assurance reviews include questions regarding the usefulness and usability of the process and process assets.

Periodic lessons learned sessions with the development teams.

Practitioners and customers feedback are obtained on six monthly basis and analyzed.

Problem reports (any time), surveys (yearly), commitment reviews (minimum of yearly; also at major program changes), and monthly meetings with project process personnel.

Process asserts available on the intranet. Documents that are checked out are tracked.

Process consultants from SEPG are associated to each project. These process consultants solicit feedback about the usefulness and usability of its process assets on a monthly basis. Further, the process improvement mechanism which exists in the organization helps in getting the feedback about usefulness and usability of the process assets.

Process documents are reviewed with the practitioners. Everyone can open process change requests.

Process Improvement Forms, Suggested Improvement Forms, Technology Innovation Requests.

Process improvement proposals. Feedback forms. Project Management Reviews.

Process improvement surveys conducted periodically.

Process Opportunity Reports are available to all engineers and are regularly submitted. Process is owned by the engineers, they know this and regularly submit PORs to improve its usefulness.

Regular surveys.

SEPG meets once in a month. This meeting is a place for discussion.

Suggestions and FAQ sessions.

Survey quarterly. the most important work we did is feed back to the staff we surveyed.

Surveys conducted by QA on QA services such as process database, audits, SEPG functions, tools/process automation.

Surveys, seeking active feedback in a planned manner in management meetings, internal audits, informal audits by SQAs, etc.

Surveys. Hassle-free work environment.

The main mechanism is review of process audit results. The results bring out the weak processes. The root cause may come out to be usefulness or usability, in which case actions are initiated. Audits happen once in 6-8 weeks

The primary method is in the yearly internal project audits, also information is gathered in the twice yearly ISO 9001 audits.

Through a defect tracking system (DDTS). Anyone (engineer to manager) can login a suggestion or difficulty in the current process system.

Through feedback tool. This tool is available on the organization Intranet.

Through Intranet based process improvement/ feedback mechanism.

Through the change request process which is always available online; through the organization process boards

Usage analysis with practitioners, SEPG meetings(monthly), Internal audits (work-product based), Internal satisfaction survey (annual), Customer Satisfaction Survey (annual), External ISO surveillance audit (6-monthly), Online feedback systems (Idea Registration System, ICARE, QTRack, CTS Online etc.,), which let any user to give feedback anytime.

Use Web-based suggestion page which is looked at weekly.

User feedback through meetings and surveys.

Various mechanism are used:(1) Formal feedback using a standard form called QCF (QMS communication form) (2) Project end learning & suggested improvements, (3) Classroom forums such as: Project managers meet, Quality team leaders meet, Center Managers Meet, Group Managers meet (4) Form based Feedback solicited during the process training sessions.

We have a process mailbox and we meet with the users in a forum on a quarterly basis.

We have a strong improvement management process which takes inputs from various different sources e.g. Employees, Contract experiences, Measurements, Internal audits, Deviation requests, Clients, External audits/assessments, External business environment and best practices. Data from these sources is analyzed half-yearly, to identify improvement opportunities.

We perform an annual survey and solicit feedback during presentations and classes on the organization standard process.

Weekly focus project coordination meetings where process focal points from each project meet to compare experiences and interact with the SEPG.

IV.8 **What appraisal methods does your organization use? (Please select as many as apply)**

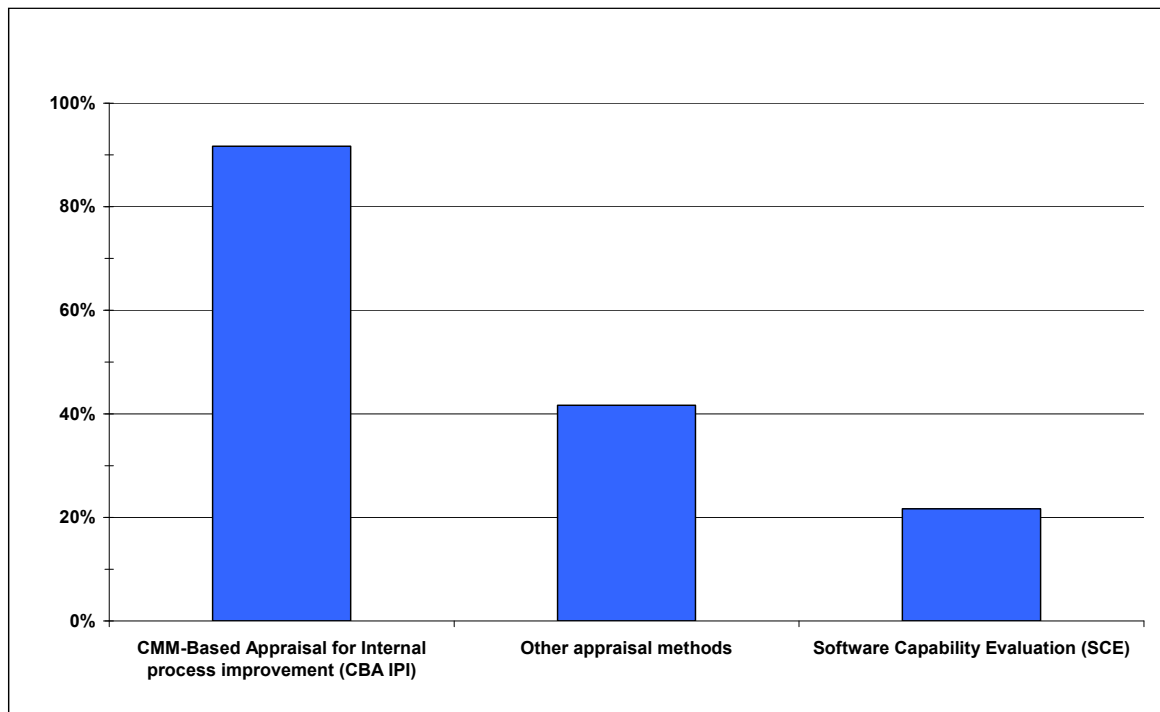|	
CMM-Based Appraisal for Internal Process Improvement (CBA IPI)	55
Software Capability Evaluation (SCE)	13
Other appraisal methods	25

Figure 19 Appraisal Methods Used

Other appraisal methods (Please describe briefly)

But moving to the new Integrated CMMI model.

CAF-compliant assessment.

CMM Quick Looks. Delivery Assurance Reviews.

EFQM is introduced recently. Being an ISO certified organization we go thru ISO certification audits once in 3 years and surveillance audits once in 6 months.

External ISO-9001 audits.

Ggap analyses; continuous appraisal method.

Internal and external ISO 9001 audits.

Internal audits based on the CBA IPI.

Internal gap analysis workshop method developed as a training/appraisal tool.

ISO 9000 (9000-3 guidelines). CE marking. FDA GMP.

ISO 9000, lean manufacturing assessment, internal quality assessment.

ISO 9000:2000 and starting a pilot with CMMI.

ISO 9001.

ISO 9001 audit and surveillance audits. Internal audits. Internal assessment and evaluation against Malcolm Baldrige National Quality Award Model (adopted as Tata Business Excellence Model).

ISO 9001 audits. TQM Assessments like IQRS.

ISO 9001 internal audit mechanism.

ISO 9001, TL 9000.

ISO 9001/TickIT.

ISO audits.

ISO certification.

ISO certification. Will go for CMMI. IBM control audits. Customer security audits.

ISO internal audits have been augmented with CMM compliance. Self governance, which deals with process compliance. Internal three-day benchmarking technique for individual programs.

ISO, SCAMPI.

KPA compliance verification on quarterly basis using in-house developed tool for every on-going project.

Monthly quick audits, quarterly detailed audits, 6-monthly ISO surveillance audits.

Motorola QSR SS-10

Motorola Quality System Review Subsystem 10.

Motorola Quality System Review Subsystem 10 (QSR SS10).

Motorola SS10 assessment - compliance with CMM assessment.

Process compliance checklist which consolidates CMM key practices and acts somewhat like a mini-assessment.

Process Professional Assessment - a CAF compliant method by Compita Limited, U.K.

Quick Scan, Philips Assessment Method, IME.

SDCE (Software Development Capability Evaluation).

Streamlined "mini-assessments" for assessing individual projects between or before formal assessments.

Tailored SCE for interim self assessments.

Working on SCAMPI.

IV.9 **When is your organization planning to be reappraised to maintain the credibility of its Level 4 or 5 rating? (Please select one)**

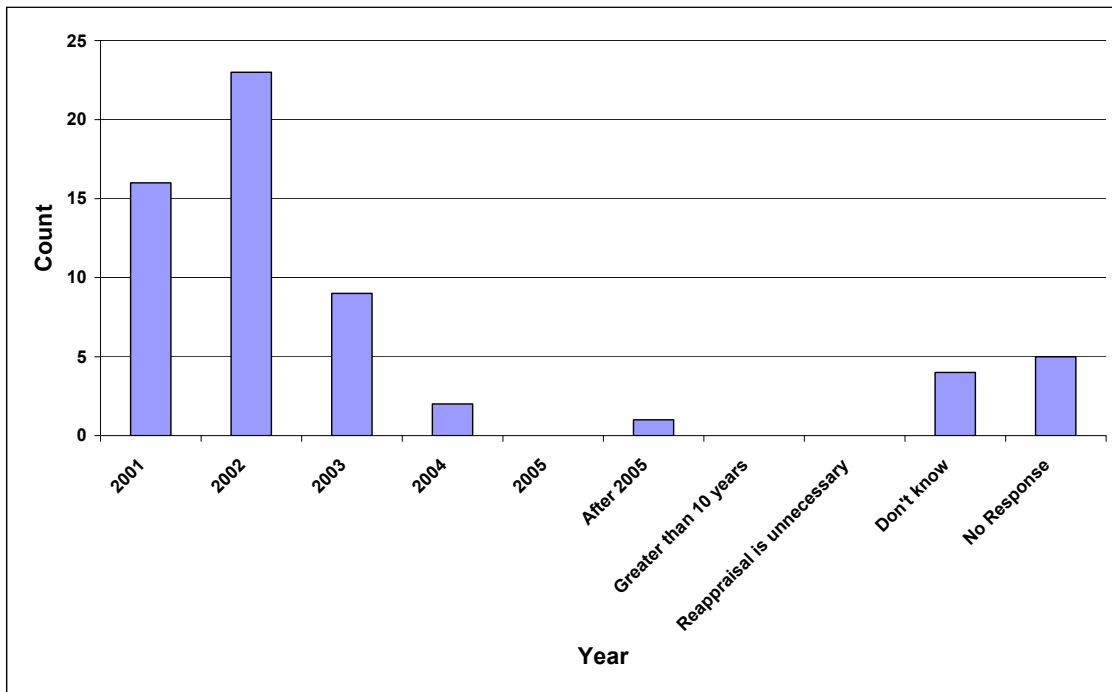|	
2001	16
2002	23
2003	9
2004	2
2005	0
After 2005	1
Greater than 10 years	0
Reappraisal is unnecessary	0
Don't know	4
No response	5

Figure 20 Year of Next Appraisal

Appendix E: Survey Section V – People Issues

V.1   **How many people are employed in your organization?**
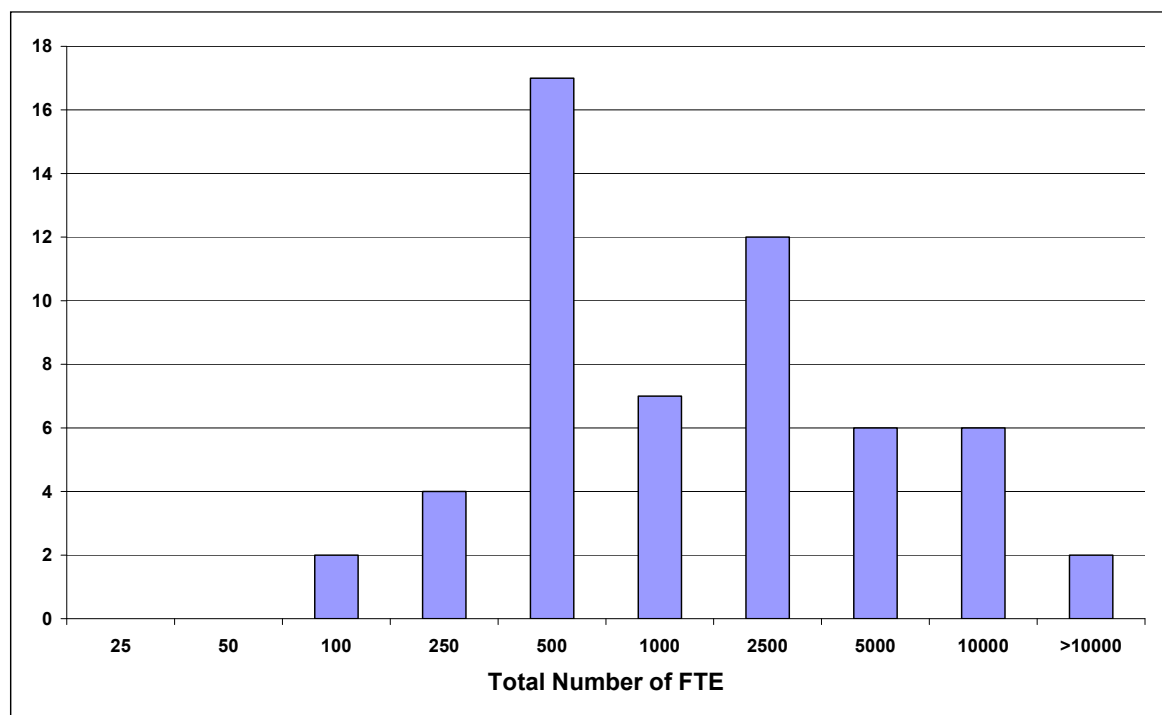
Total number of full time employees

Figure 21 Total Number of Full-Time Employees

**Number of full time employees primarily engaged in software development, mainte-
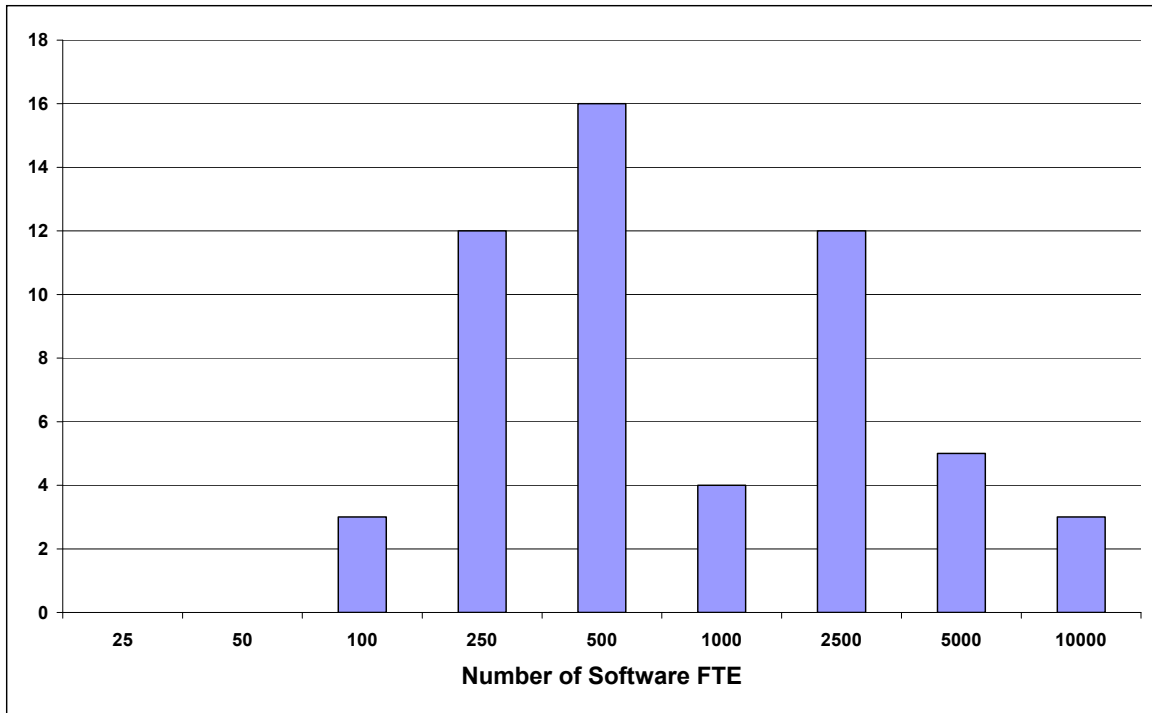nance, or support**

Figure 22 Number of Software FTE

Number of FTE which are part time, consultants, or other forms of labor, primarily engaged in software development, maintenance, or support
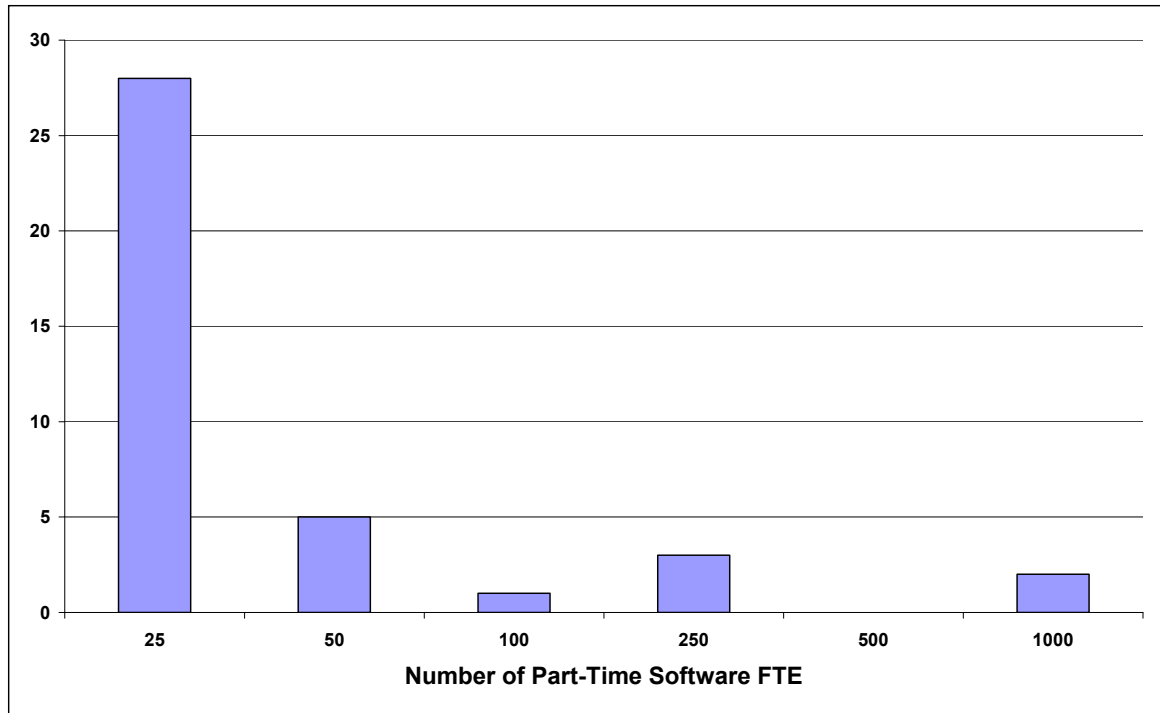

Figure 23 Number of Part-Time Software FTE

Table 5 Summary of Employee Information

V.1 Employees	Total FTE	Software FTE	Part-Time FTE
N	56	55	39
Average	2685	1349	71
Median	767	450	9
Maximum	30000	8500	1000
Minimum	60	55	0
Standard Deviation	5051	1996	190

V.2 **Approximately how many full time employees primarily engaged in software development left the organization during the past 12 months? (i.e., what was your yearly turnover or attrition rate?)**
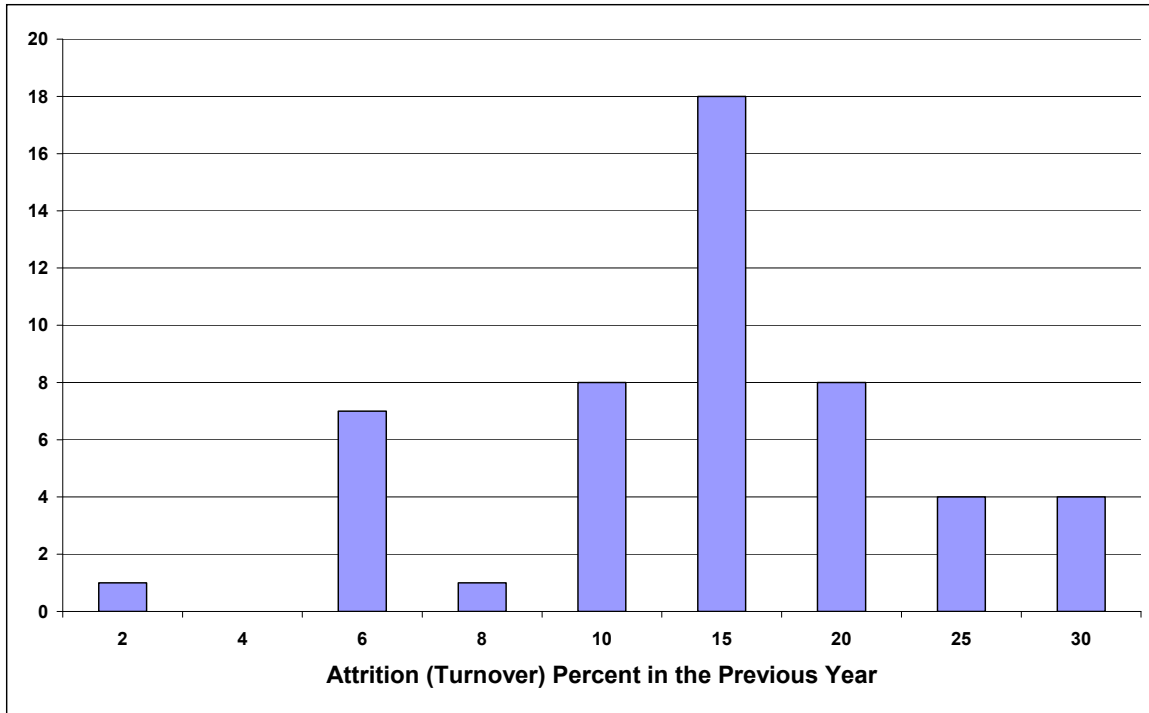

Figure 24 Attrition (Turnover) in Percent in Past Year

V.3 **Approximately how many full time employees primarily engaged in software development joined the organization during the past 12 months? (i.e., what was your yearly growth rate?)**

%

V.2 and V.3 – Attrition and Growth	Attrition (percent)	Growth (percent)
N	51	52
Average	14	31

V.2 and V.3 – Attrition and Growth	Attrition (percent)	Growth (percent)
Median	12	21
Maximum	30	200
Minimum	1	0
Standard Deviation	7	33

V.4 **Approximately what percentage of the organization's effort is spent in process improvement activities (including both full time SEPG and part time effort on process action teams)?**
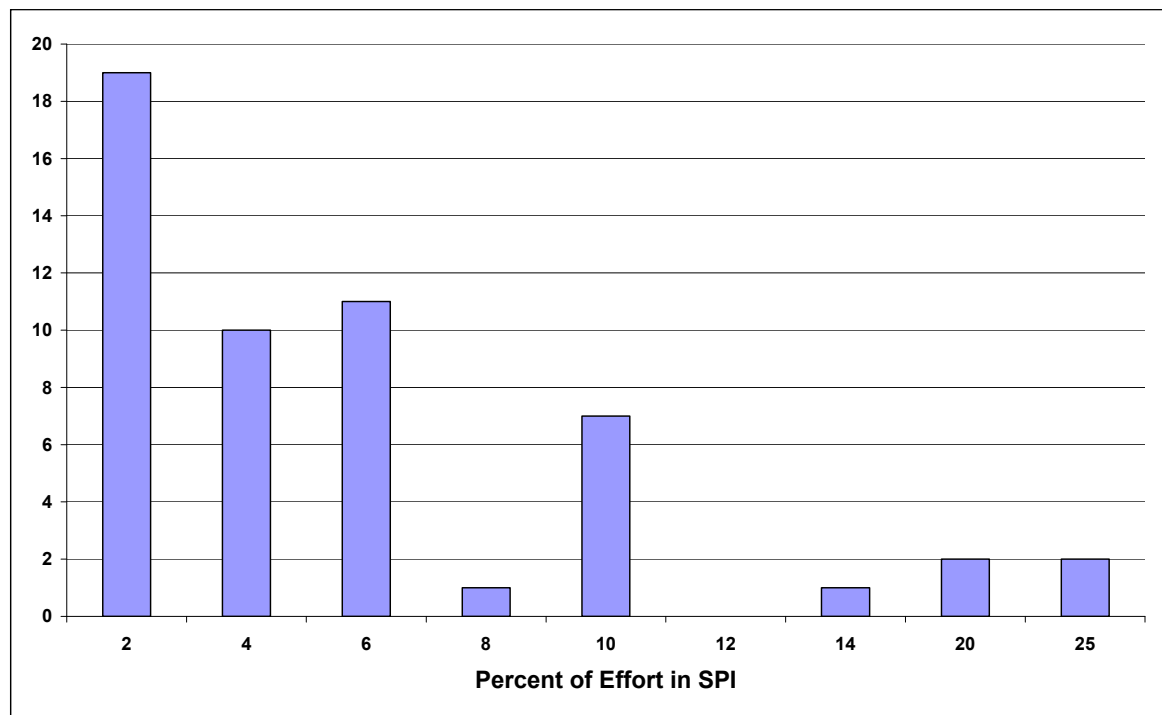

Figure 25 Percent of Effort in Software Process Improvement

V.5 **Approximately what percentage of the organization's effort is spent in SQA activities?**
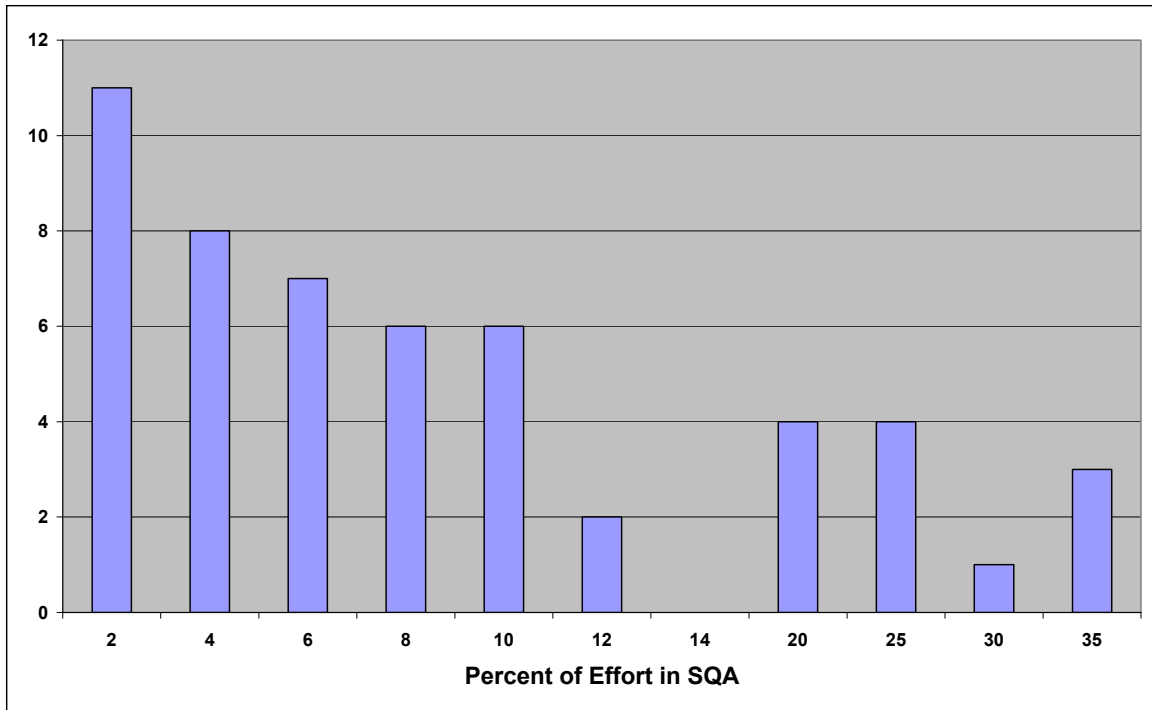
Figure 26 Percent of Effort in Software Quality Assurance

V.4 and V.5 – SPI and SQA Effort	SPI Effort (percent)	SQA Effort (percent)
N	53	52
Average	5	10
Median	3	7
Maximum	25	35
Minimum	0	1
Standard Deviation	5	10

V.6   Approximately how many days of induction training does your organization provide to new hires?
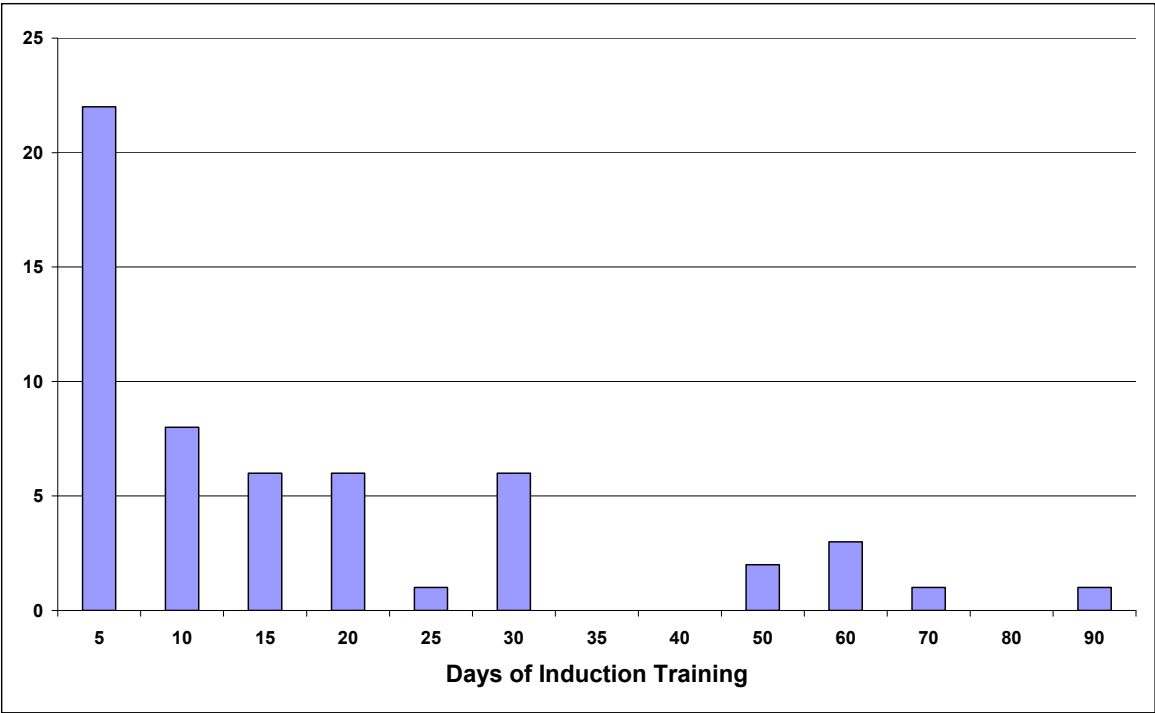
Figure 27 Days of Induction Training

V.7 **Approximately how many days of continuing education or capability training do employees get per year in your organization?**
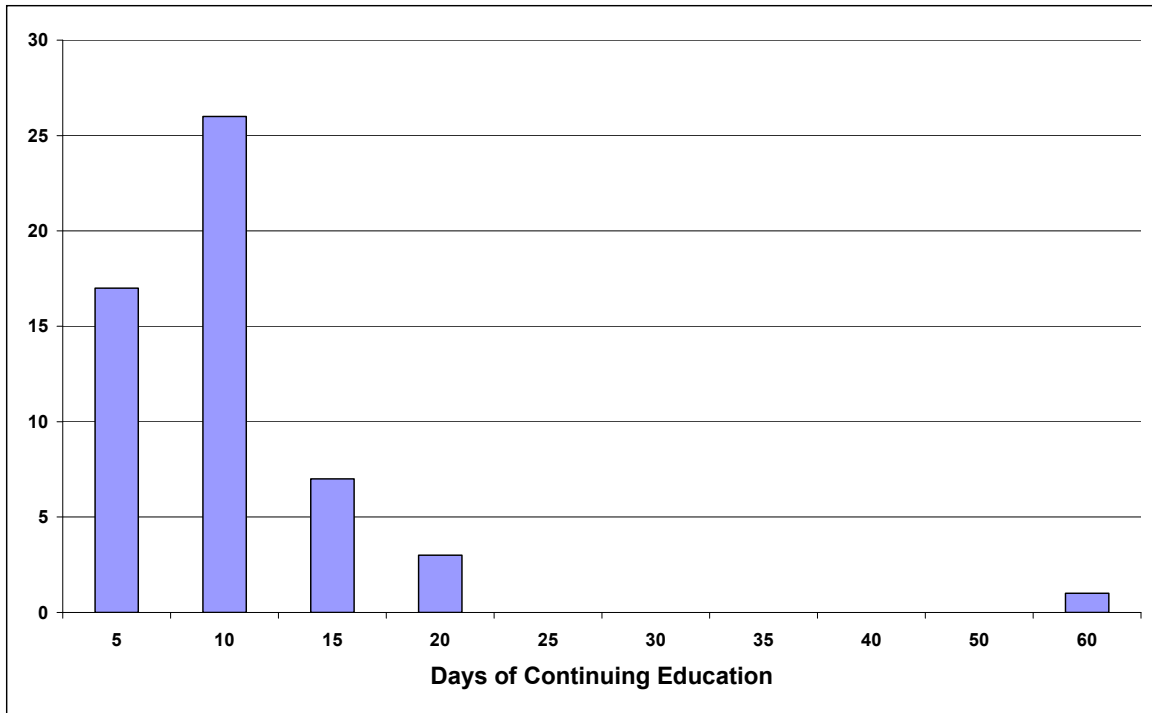
Figure 28 Days of Continuing Education Training

V.6 and V.7 – Induction and Continuing Education	Induction training (days)	Continuing education (days)
N	56	54
Average	17	9
Median	10	8
Maximum	90	60
Minimum	1	2
Standard Deviation	20	8

V.8 **Does your organization have a formal mentoring program? (e.g., long term relationships with experienced and knowledgeable mentors) (Please select one)**

No	23
Yes	32

Yes (Please describe briefly here)

All functional areas have "mentoring checklists."

All managers are engaged in mentoring program.

Each account will have intranet page. Formal mechanism to train the new joinees to account is commonly followed

Each new hire or transfer is given a mentor, they are available for the first 6 months.

For projects and QA specific and CBT training program, mentors are identified and they evaluate the training performance.

Formal mentoring program is there but it does not mandate a very long term relationship but a well defined plan for mentoring which ends at pre defined time

In some situations and job categories, a mentoring program has been established. Both the mentor and the "mentee" are interviewed to ascertain the value of the program.

Informal.

Launched recently.

Life guards. Technical mentors.

Mentoring is available on a need basis and is initiated using the appraisal mechanism.

Mentoring is usually done for re-orientation of skills. Currently one of the mentoring initiatives is towards mentoring project managers for PMI certification by project managers who have already been certified. Several on the job training initiatives are carried out across the organization where experiences professionals play the mentoring role.

Mentoring program.

Mentoring programs exist at senior management levels. Senior professionals mentor groups of 5-10 each. Mentors/sponsors provide on-going feedback and support to the mentored.

Mentors trained in mentor process; mentor accountability in performance plans; new hires assigned mentors; mentor selection criteria; mentor training tracking records.

Mentorship program taught by local university psychology professor; existing for over ten years.

Multiple formal programs: presidential mentees; program managers; architects.

New campus hires are assigned a senior developer as a buddy for two months to help them better understand the company processes and engineering practices.

New hires assigned a buddy on first day - they are part of mentor for getting assimilated.

Part of the training of new development engineers is the mentoring by their team leader. We make sure that the amount of new engineers in teams does not exceed 1/4 in development teams (in test teams it is usually around 1/3). The mentoring tasks are planned and tracked.

Primarily focused on "new/college" hires.

Program to recruit experienced mentors and match with mentees. Guidelines, handbook, workshops available to both.

Seasoned engineers are assigned to new employees until formal (documented) OJT and mentoring objectives are completed.

Senior engineer spend 2 weeks in mentoring training program to be a mentor. Typically a mentor has 2-4 mentees assigned to them. Assignment is 1-3 years.

Senior staff, are designated as group managers, to take care of specific project delivery, as well as people management of identified group of people. Responsibilities include performance planning and review, training and development needs identification, counseling/career planning, and assisting in assignment to specific projects/assignments.

There is a dedicated group part of HR to do this activity.

We call this as buddy program. For every new hired staff, there are few buddied in different categories who will responsible for different knowledge sharing. We have role based training program to develop the experienced staff

We have a group of "Fellows" identified who are officially qualified/certified as mentors in certain fields.

V.9   Does your organization provide its employees with required training in ...?

Technical skills of software engineering	56
Management skills	58
Meeting management	31
Change management	45
Domain knowledge	50
Interpersonal skills	47
Principled negotiation	20
Team building	53
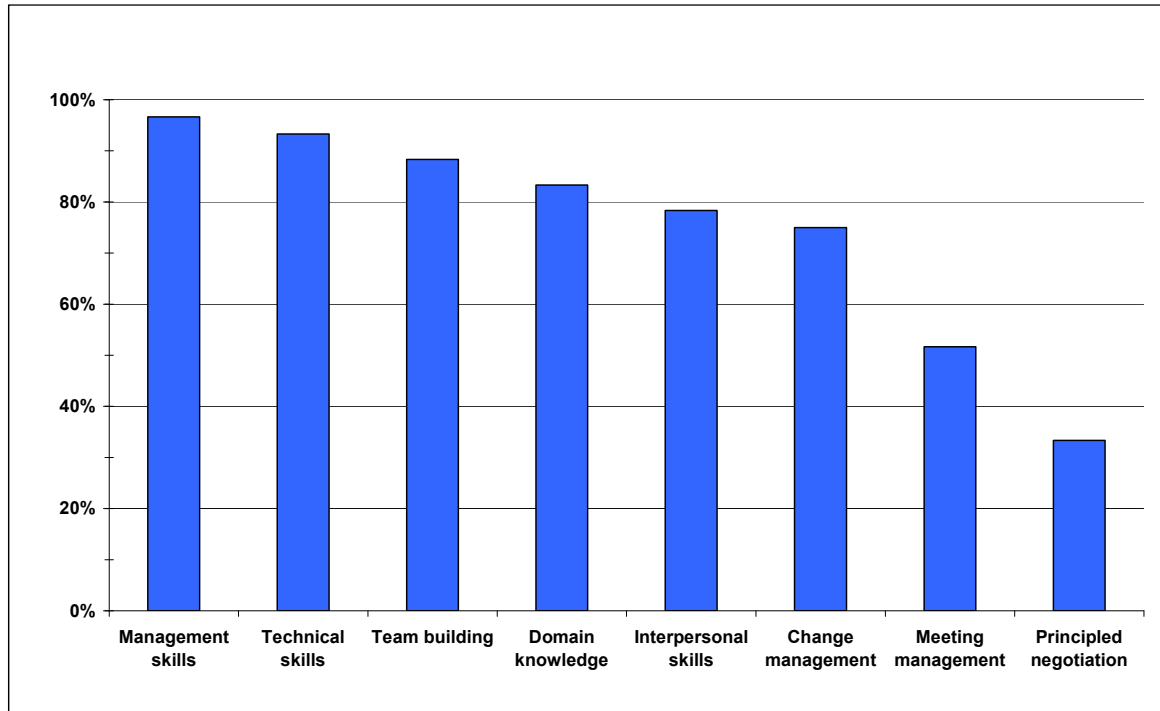
Figure 29 Required Training Topics

**V.10   In what kinds of work spaces do the technical staff in your organization typical-
ly work?**

xxxxx% ... in private offices

% ... in shared offices

% ... in individual cubicles

% ... in other open work spaces

% ... working from home

V.10 Workspace	In private offices	In shared offices	In individual cubicles	In other open work spaces	Working from home
N	42	40	50	35	23
Average	11	25	46	52	1
Median	5	5	33	67	0
Maximum	58	100	100	99	5
Minimum	1	0	1	0	0
Standard Deviation	13	32	39	41	2
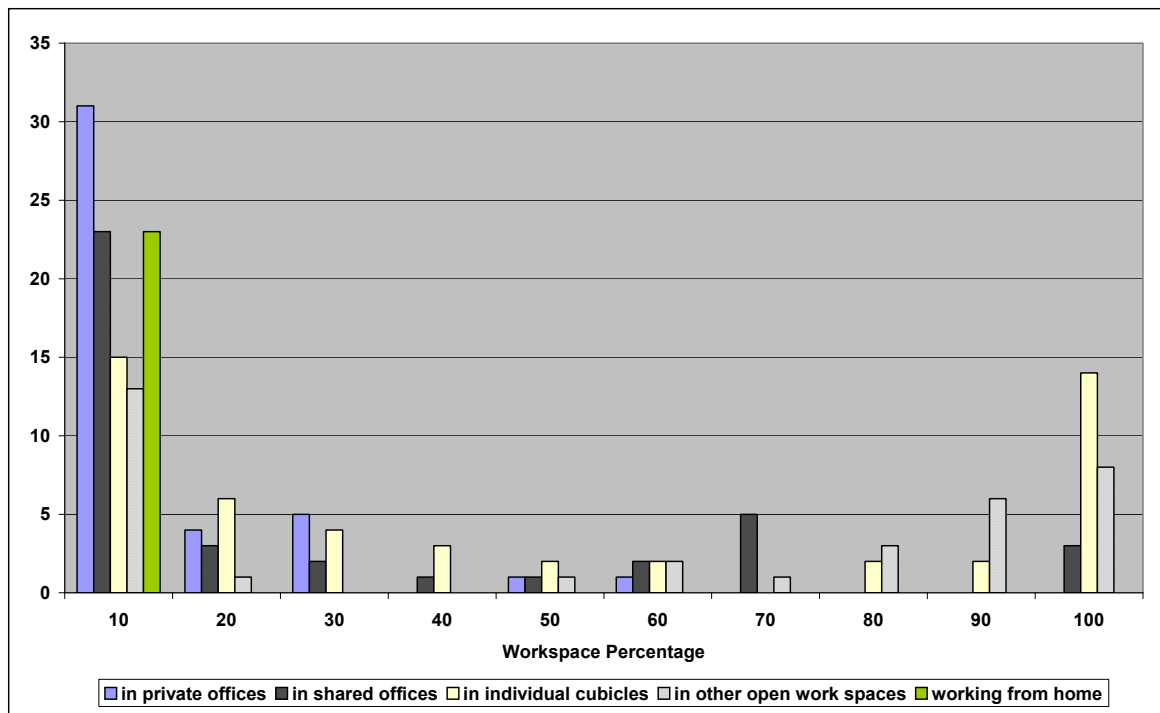
Figure 30 Workspace Allocation

Appendix F: Survey Section VI –
Background Information

VI.1   Approximately how much of your organization's business is devoted to software (or the software in software intensive systems)?

% ... Development

% ... Maintenance

% ... Acquisition

VI.2   When did your organization begin work on improving its software processes? (Please approximate to the nearest year.)

Prior to 1990	15
1990	2
1991	4
1992	5
1993	8
1994	6
1995	2
1996	9
1997	3
1998	0
1999	0
2000	0
Don't Know	0
No Response	6
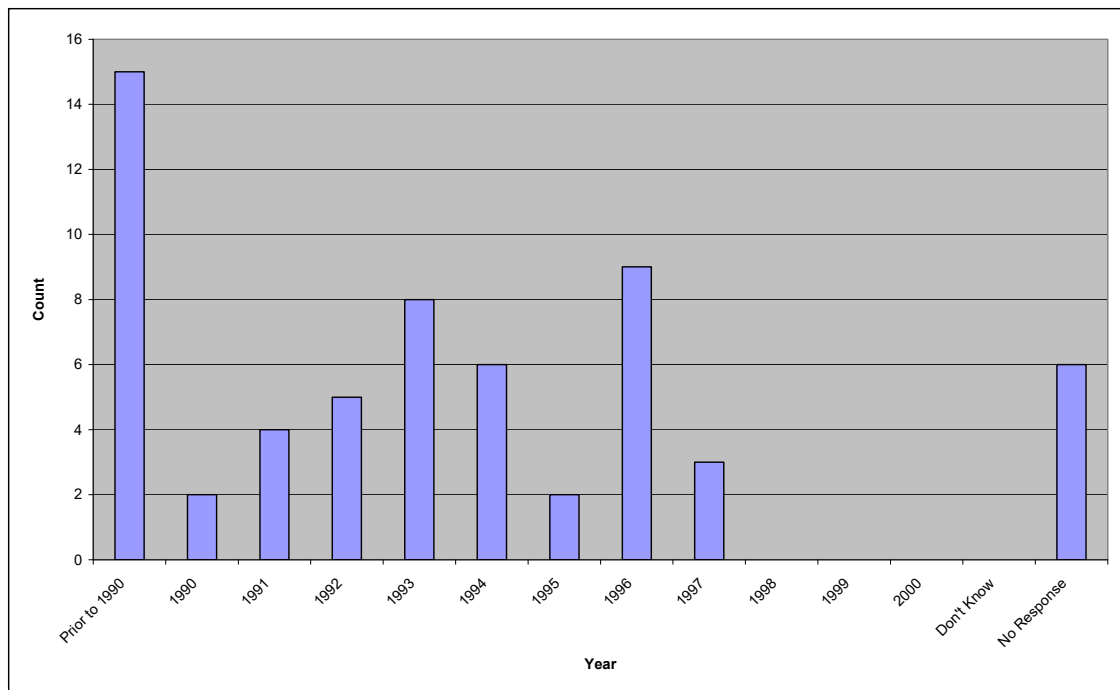
Figure 31 Year Began Software Process Improvement

VI.3   In what year was your organization assessed at ... ?

VI.3 Year Assessed	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4	Maturity Level 5
1988					
1989					1
1990	1	1			
1991	2	2			
1992	1	1	1		
1993	1	3	3		1
1994	1	5	4		
1995		1	2	2	
1996			9	1	
1997			5	7	1
1998			1	7	2
1999			1	13	13
2000				9	12

VI.3 Year Assessed	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4	Maturity Level 5
2001				2	2
Not Applicable	21	16	8	8	6
No Response	32	30	25	10	21

VI.4   How is your organization best described?

|	
Defense contractor	12
Other government contractor	4
Department of Defense or military organization	3
Other government agency	0
Commercial shrinkwrap	2
Custom software development	21
"In-house" or proprietary development or maintenance	5
Other industry or commercial (e.g., manufacturing; health or pharmaceutical; finance, insurance, or real estate; wholesale or retail trade)	4
Other	3
No response	6

How is your organization best described?
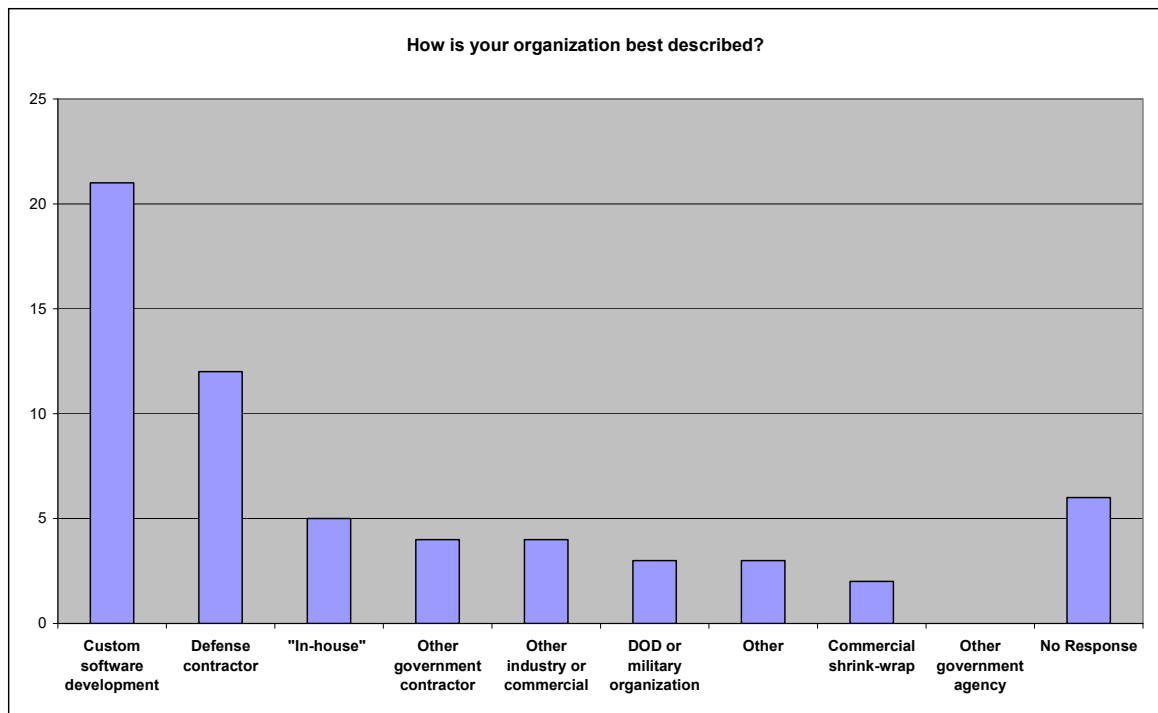
Figure 32 Type of Organization

Other industry or commercial (e.g., manufacturing; health or pharmaceutical; finance, insurance, or real estate; wholesale or retail trade)

Custom telecommunication infrastructure solutions.

Motorola Global Software Group (GSG) is the key software development unit in Motorola. Our organization is part of GSG.

Software architects and services company.

Software service provider.

Telecommunications system provider; embedded software.

We develop software products for the banking and finance industry. We also provide services to the banking and finance industry.

Work on customer application software or software products in areas of development, maintenance, or support.

Other (Please describe briefly)

Bespoke software development.

Development of software for needs of business operations, and tools and technology around which applications can be built. Products also cater to areas such as CRM, ERP, etc.

Leading IT software company providing productized and software services for around 400+ clients world wide.

Software development and consultancy services in the domains of insurance, banking, utilities, telecom, transportation, mortgage, security, healthcare, and quality assurance.

VI.5 **For what major application domains does your organization develop, maintain, or acquire software or software intensive systems? (Please select as many as apply.)**

Management Information Systems (e.g., systems supporting business operations such as payroll, accounts receivable, payable, inventory, or logistics)	27
Real Time Applications (e.g., process control, manufacturing, automation, guidance systems for avionics or radar)	33
Embedded Systems (e.g., software running in consumer electronic devices, vehicles, fuel control, military systems)	38
Other	11

Other (Please describe briefly)

Also work on system software such as operating systems, microelectronics, and VLSI.

Application domains: banking, insurance, financial, manufacturing, defense, retail, MIS, transportation (airline, road, railway)

Automatic test equipment.

Commercial applications.

Command and control.

Finance, insurance, manufacturing, telecom, and datacom.

Medical industry - software that controls medical imaging scanners (MRI, computed tomography, X-ray, mammography, PET, nuclear medicine, ultrasound, etc.). Image processing and post processing. Image archiving, networking - e.g. teleradiology. Remote diagnostics.

Medical systems.

Network operation and maintenance.

Retail, logistics, financials, technology are the core business areas.

Software tools development, telecommunication system development, e-business development.

Telecom and networking.

Telecommunication/networking.

VI.6   Does the organization concentrate its efforts on ... ? (Please select as many as apply)

A core product line or application domain (e.g., switches, guidance systems, information systems, or database systems)	34
A core technology (e.g., distributed systems, real time embedded systems, object oriented design, or simulators)	31
Life or mission critical systems	19
Extremely large or complex systems	30
New or poorly understood domains or technology	11
Other special focus	7

Other special focus (Please describe briefly)

Business applications. ERP.

Ours is a commercial software organizations where we develop software for lines of business and technology.

Re-engineering.

Software services.

Software tools development, telecommunication system development, e-business development.

The organization does not focus on a single, core product line.

Various areas.

We are a service provider for a variety of business applications covering diverse platforms and languages for simple to complex systems.

WEB, WAP, CIS, mainframe.

VI.7   How is the organization structured? (Please select as many as apply)

Functional (i.e., by common specialties such as finance or engineering)	28
Product (i.e., by units responsible for a product or product line)	26
Customer group (e.g., targeting customers such as the US Navy or General Motors)	19
Territorial (e.g., Northeastern marketing zone)	14
Matrix (i.e., a mixed project and functional organization)	30
Process (i.e., by flow of work such as IPPD)	6
Other	1

Other

A group may be on the basis of any of the above.

By technology areas such as eCommerce, middleware, and application management.

Software engineering and technology center (SETC) is an independent department in the organization.

We are organized by program, F16, F22, etc., but we develop software by domain, flight controls, avionics, ground systems, etc.

We have practice units aligned to global geographical locations with a matrix reporting structure.

VI.8   Does your organization have a total quality management (TQM) or other similar program?

For the assessed organization	11

At a higher corporate or similar parent level	9
Both of the above	26
Neither	8
No response	6

VI.9   Is the organization ISO 9001 certified (Quality Management Systems)? (Please select one)

No	10
Yes	43
No response	7

In what year was the organization first certified? (Please Specify)

Xxxx

VI.10   What, if any, other quality or process improvement models, approaches, or emerging standards does your organization use in its improvement efforts? (Please select as many as apply)

ISO/IEC 12207 (or IEEE) "Software Life Cycle Processes"	22
ISO/IEC 15504 "Software Process Assessment"	8
ISO/IEC 15288 "System Life Cycle Processes"	6
ISO/IEC 15939 "Software Measurement Process Framework"	5
Balanced Scorecard	25
Six Sigma	25
Malcolm Baldrige	15
CMM Integration (CMMI)	29
FAA iCMM	1
Systems Engineering CMM (SE-CMM)	9
Systems Engineering Capability Assessment Model (INCOSE SE-CAM)	3
EIA/IS 731	7

Software Acquisition CMM (SA-CMM)	4
People CMM (P-CMM)	23
Other	5

Other

Extreme Programming and agile methodologies seem to be gaining ground.

Five Nines.

IQRS-TQM framework from DNV. EQA-TQM Framework from EFQM. RPGQA-TQM Framework from higher corporate.

ISO 9001:2000.

Just started Six Sigma.

Performance excellence (like European quality award model) is used here.

Philips Business Excellence (PBE) model based on Business Excellence Model by European Federation for Quality Management(EFQM).

TickIT and IEEE standards.

TL9000.

TL-9000, ISO 14000

TL9000.

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