SOFTWARE PROCESS ASSESSMENTS

Sharon E. Miller
George T. Tucker
Anthony J. Verducci, Jr.
AT&T Bell Laboratories, USA

Software process assessments (SPA's) are part of an on-going program of continuous quality improvement in AT&T. Their use has been found to be very beneficial by software development organizations in identifying the issues facing the organization and the actions required to increase both quality and productivity in the organization.

INTRODUCTION

The AT&T Software Process Assessment program is part of the overall software quality improvement activities in many of the software development organizations across the company. Assessments are a service provided to a project or organization for the purpose of baselining the processes used for software development and developing an action plan for improvement activities. In addition, the data collected over time is used to identify corporate strengths and weaknesses and to drive corporate level efforts aimed at improving the software development environment.

AT&T has chosen to implement its assessment program using a trained assessment team that is independent of the software development organization. The benefits of this approach will be discussed in conjunction with describing the experiences of customers within AT&T who have had one or more assessments.

CUSTOMER EXPECTATIONS

Customers have a number of expectations about an assessment, the process, and the findings, and meeting these expectations is critical to the success of any individual assessment and to the assessment program. Many of these expectations are ones that customers can articulate at the outset. Others, however, are implicit expectations that experience has shown are important to customers, but that are not recognized by customers as being important until the process is completed. The most important expectations are listed below:

o The assessment team must fulfill its commitments in a timely fashion,

o The assessment must be independent and objective,

o The assessment must accurately identify the organization's strengths and weaknesses,

o The feedback must be professional and non-threatening,

o The results must be confidential, and

o The findings and recommendations must include a roadmap for follow-on action plans.

Fulfilling Commitments

An assessment is a significant undertaking for an organization in terms of cost and effort. The average assessment for a moderately sized project is approximately 30 staff days of time for the assessment team and 30 staff days of time for the project. As such, the assessment must be planned and managed, as would any project task. Each assessment is assigned a project leader from the assessment team, who is responsible for all of the customer interfaces, including establishing the schedules, working the details of the assessment implementation, and ensuring all assessment team commitments are fulfilled. Likewise, a project coordinator from the organization being assessed is identified to work with the assessment leader to coordinate all the logistics, such as selecting participants, getting meeting rooms, sending out meeting notices, and ensuring all project commitments are fulfilled.

To facilitate this process, the assessment leader meets with the project coordinator, provides the coordinator with a checklist, and makes sure the coordinator clearly understands what the assessment team will be doing and what the project must do throughout the life-cycle of the assessment. The assessment leader then assumes the responsibility for following up at each step of the process to ensure all activities are performed as agreed.

Independence and Objectivity

While it is possible for an organization to perform a self-assessment, experience in AT&T has shown that having a trained assessment team not associated with the project is more effective. The objectivity is perceived to be higher when the assessment team has no vested interest in the results or the subsequent changes that are recommended for

improvement. Even though the data represents the views of the members of the project team participating in the assessment, management tends to be more accepting of the results and the recommendations when they come from an independent organization. Also, an independent team can deliver a "bad news" message more easily, particularly if it involves issues like management style, communication or decision making.

Identification of Strengths and Weaknesses

Key to the success of the assessment from the customer perspective is the ability of the assessment team to identify, from the data collected, the key strengths and weaknesses in the organization. The customer will not be satisfied with the assessment results if this is not done accurately. Thus, it is important for the assessment team to adequately explore all the pertinent issues during the data collection period, so that each strength or weakness can be supported by fact.

Having an assessment performed as a mechanism solely to understand where to focus quality improvement efforts carries an implicitly negative connotation. The expectation is that the organization will be given a laundry list of deficiencies and recommendations to address them. Experience has again shown that the approach taken in AT&T, in which the assessment balances the feedback to include both strengths and weaknesses, meets customer expectations for learning their deficiencies, but does so in a much more positive fashion.

Another reason for balancing the strengths and weaknesses is to reinforce the things a project is doing very well, so it does not lose sight of them or stop doing them while focusing attention on efforts to improve the deficiencies.

Providing Feedback

As mentioned above, the feedback to an organization must be handled professionally, so that the overall result is a positive one. While the goal is to have an organization take action on deficiencies uncovered during the process, it is equally important to ensure that the organization buys into the feedback. This means having concrete data to support the findings and using lots of specific project examples when discussing the findings. The assessment team must be adequately prepared to discuss all aspects of the findings in detail to ensure credibility and acceptance of the results.

Maintaining Confidentiality

Another very critical success factor is the confidentiality of the data. This confidentiality occurs at two levels. First, the team from the project that provides the data to the assessment team must feel confident that their individual comments will not be disclosed to management. The assessment team needs to address this issue before the data is collected and honor this commitment to confidentiality throughout the process.

The second level of confidentiality is at the project level. The data collected and the resulting feedback belong to the project and are considered to be private. The assessment team must again, at the start of the process, ensure that the project coordinator understands that other than using the data to determine corporate averages and trends, the data will not be released to anyone but the project coordinator without the project or organization's permission. This agreement must be scrupulously honored by the assessment team.

Developing Action Plans

The real work begins when the assessment is completed and the project must undertake the planning and implementation of quality improvement activities. While these activities are generally beyond the scope of the assessment, projects have varying expectations as to how this will be managed. Several alternative approaches have been used within AT&T.

A first, and common approach, is for the project to set up quality or process improvement teams to address the assessment recommendations. These teams will have the responsibility to examine the areas for improvement, to formulate a plan of action, and to oversee the implementation of the process changes. The implementation of the process changes may be undertaken on a trial basis or applied to the entire organization, but each change must be monitored for a period of time to ensure that the expected improvements are in fact occurring.

A second approach taken by some projects is to ask the assessment team to participate with project members in the formulation of the action plan. It is important to note that the participation must be consultative and the project must clearly accept the responsibility for the ownership of this activity and the resulting process changes. It is not within the power of the assessment team to drive changes within an organization.

A third approach being tried is to assign a process engineer, who is an experienced software consultant, to the project at the completion of the assessment. The assessment results are provided to a process engineer who then works with the project on an ongoing basis as they develop and implement process changes. An advantage to this approach is the process engineer is dedicated to the project, while at the same time has access to a wide range of other experts, practices, and tools that can be used to help the project.

CUSTOMER EXPERIENCES

AT&T has done nearly 100 assessments since 1987 using one or two widely accepted instruments, the Software Engineering Institute's (SEI) Capability Maturity Model/1/ and the Software Productivity Research[1] (SPR) CHECKPOINT™ questionnaire/2/. The SPR instrument was modified for use in AT&T and has been used in all the assessments. The SEI questionnaire is unmodified and has been used in roughly 40 assessments since mid 1990. Because the two instruments have a different focus, the SPR looking primarily at detailed process effectiveness and the SEI looking at overall process management, they are administered differently.

SEI Consensus Meeting

As indicated above, the SEI questionnaire is management oriented, so the organization is asked to convene a meeting(s) of their management team(s) and to have the team(s) reach consensus on each question in the questionnaire. Most management teams find this meeting is extremely valuable because of the discussions that result from trying to reach consensus on how different activities are being managed in the organization.

Another valuable use of this data is that it provides the management perspective on the software development process, and this perspective is not always the same as that of the software developers. For example, in one assessment, the management team indicated that the organization had documented methods and standards for the software development process, but when the developers were interviewed, they indicated that, while there was a document, the use of the methods and standards was optional.

---

[1] CHECKPOINT is a trademark of Software Productivity Reasearch, Inc., a company founded and headed by Capers Jones, a recognized expert in the area of software quality and productivity.

SPR Consensus Meeting

The AT&T version of the SPR questionnaire contains approximately 300 questions. The answers to the questions, which are generally on a 1-5 scale, indicate how the organization is doing relative to the software industry for that particular area. For example, if the sample question shown below were answered, a score in the 1 to 2.5 range would indicate the project is leading edge with respect to the software defect data collection function, a score in the 2.6 to 3.4 range, would indicate the project is at industry norm, and a score 3.5 or greater would indicate the project is at high risk relative to the software industry as a whole. The question structures are the result of Capers Jones' extensive experience in the software field.

Software defect data collection?:

1) Defect data collected from requirements onward

2) Defect data collected from design onward

3) Defect data collected from testing onward

4) Intermittent or partial defect data collection

5) No defect data collection

In the AT&T process, representatives from the software development staff, not generally managers, are asked to fill out the questionnaire, and to then attend a one day meeting, during which the group is expected to reach a consensus answer on each question. All major software development life cycle activities are represented, including requirements, architecture, design, implementation, test, product support, and user documentation. To help the group reach consensus, the assessment team facilitates a discussion of each question. This meeting generates a great deal of discussion among the participants and provides a great deal of insight into the organization.

Most groups find that the meeting is informative, and often it is the first time people representing different functional areas have the chance to understand the issues faced by others. For example, it may be the first time the person responsible for preparing customer documentation and the software developers have a meaningful discussion on the documentation process and its effectiveness.

Hard Data

In addition to the data collected through the two questionnaires, there is additional data requested of a project. This data is referred to as hard data because it is quantitative in nature, asking for things such as staff effort by development phase, start and stop times for development phases, defect counts, etc. In general, a single person in the organization is asked to collect this data. This data is used to calculate productivity for the project and to validate information from the SPR session.

Feedback Session

After the data has been collected and analyzed, the project is invited to a feedback session to hear the results of the assessment. Experience has shown that the most successful assessments are those in which top management has been involved and supportive. It is especially important that top management is present at the feedback session and shows a commitment to the improvement process. One of several vehicles used to give a project a snapshot of the effectiveness of their software processes is shown in Figure 1. This is called a kiviat or spider chart.

The kiviat graphically depicts how a project is doing in each of eight categories, using the same 1-5 scale discussed previously. 10-20 questions from the SPR questionnaire are associated with each of the eight categories. The categories are defined below. The average scores for these questions are then plotted to form the kiviat. In this representation, the closer a score is to the center of the chart, the better the project is doing in that particular category. In Figure 1, for example, this hypothetical project is doing particularly well in the customer focus, project team variables, tools, physical environment, and metrics areas, and is at industry norm in the project management and methodologies areas.

Customer focus includes questions that deal with the level of customer involvement in the various stages of product development, including requirements, prototyping, customer documentation, and acceptance testing.

Project management looks at the experience of the management team on similar projects, the effectiveness of estimation and scheduling, and other project management issues.

Project team variables assesses the experience and training of the staff on the project.
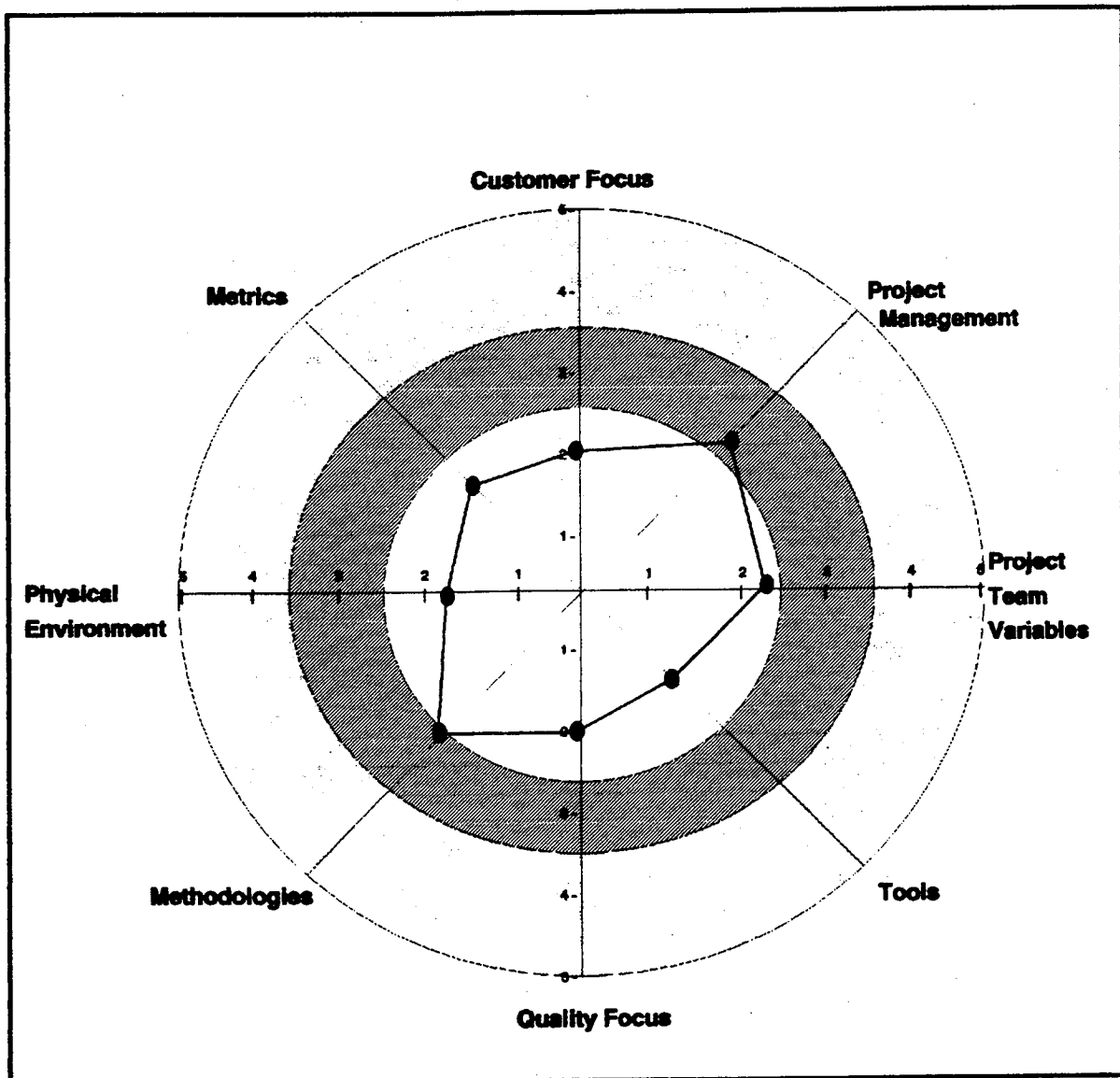
Tools looks at the effectiveness of the coding and non-coding tools used by the project.

Quality focus assesses the quality assurance activities used throughout the life cycle of the development effort.

Methodologies looks at the effectiveness of the methods used in the development activities, from requirements and design methods to testing methods.

Physical environment asks about the development and target hardware, the physical office space, and staff support issues.

Metrics looks at the type of data that is collected and used by the project.

Hypothetical Project Kiviat Chart
Figure 1

In the feedback session, the project strengths and weaknesses are discussed in the context of the 8 kiviat categories. Areas that scored in the average range are not generally discussed, because the intent is to reinforce the strengths and to encourage improving the weaknesses. Feedback from projects assessed indicates that the process usually identifies the most significant strengths and weaknesses in an accurate and objective way. Feedback also indicates that, in general, projects are not very surprised at the findings.

Another positive finding is that all the projects assessed indicate a desire to change as a result of the findings, and begin to address the recommendations immediately. Also, most projects indicate a desire to undergo a reassessment in 18-24 months to gauge how well their improvement program has worked.

Action Plans

The most important activity following an assessment is the preparation of an action plan to address the assessment findings. The three options for preparing action plans were discussed earlier. Within AT&T the most common approach has been for the projects to tackle the action planning and improvement activities using project personnel. A positive aspect of taking this approach is that the project takes full ownership of the planning and the improvement activities, and to the extent that management follows through with support during the implementation phase, it has a high success rate in terms of lasting improvement. A disadvantage of this approach is it may not take full advantage of the resources available across a company as large as AT&T, in terms of using solutions that have been tried and proven in other organizations.

To help identify the broadest set of solutions possible, the assessment team, if the organization desires, will prepare a proposal for improvement at the conclusion of the assessment. This proposal identifies resources, tools, and techniques that the organization might use in implementing an improvement program. Members of the assessment team are also available for on-going consultation with the organization.

AT&T also has a program that publishes and supports "Best Current Practices[2]" which helps to disseminate good development practices among organizations. This program is supported with documentation, training, and a "best practice owner," an expert on that particular practice, who is available for consulting with projects. Additionally, this program fosters the sharing of personal experiences among projects, which this has been found to be one of its greatest benefits.

---

[2] Activities that have been identified as beneficial are documented and supported through documentation and training. Examples of best current practices are code inspections and root cause analysis.

Reassessing an Organization

Implementing an improvement program takes time and patience, and the time required to see lasting benefits of the changes varies with the improvement being undertaken. For example, a project that implements an inspection program for requirements and design documents is likely to see tangible benefits of this program early in the next development cycle, while a project that needs to implement a formal estimation process will not be able to judge the benefit of the process until data has been collected and compared to the estimates over a full software development cycle.

In AT&T's experience, 18-24 months is a reasonable time between assessments. In this time period most projects will complete a full development cycle, and will have enough data on the effectiveness of the changes implemented to make a reassessment meaningful. It is important in a software assessment that the processes being discussed are those in use, not those that are planned for a future development cycle.

As an example, one AT&T project has participated in the assessment program since 1987, having had assessments in 1987, 1989, and 1991. Following each assessment, the project put in place plans to address the weaknesses identified, and in each subsequent assessment, very clear improvement was noted. Projects with results similar to this are understandably proud of their progress, and generally willing to share their success stories with other projects just starting an improvement program. Figure 2 below is an example of the type of progress that can be made over a four year period in terms of a pie chart. The pie chart is an overall measure of the number of areas where the organization is leading edge, at industry norm or at high risk, relative to the questions in the SPR questionnaire.
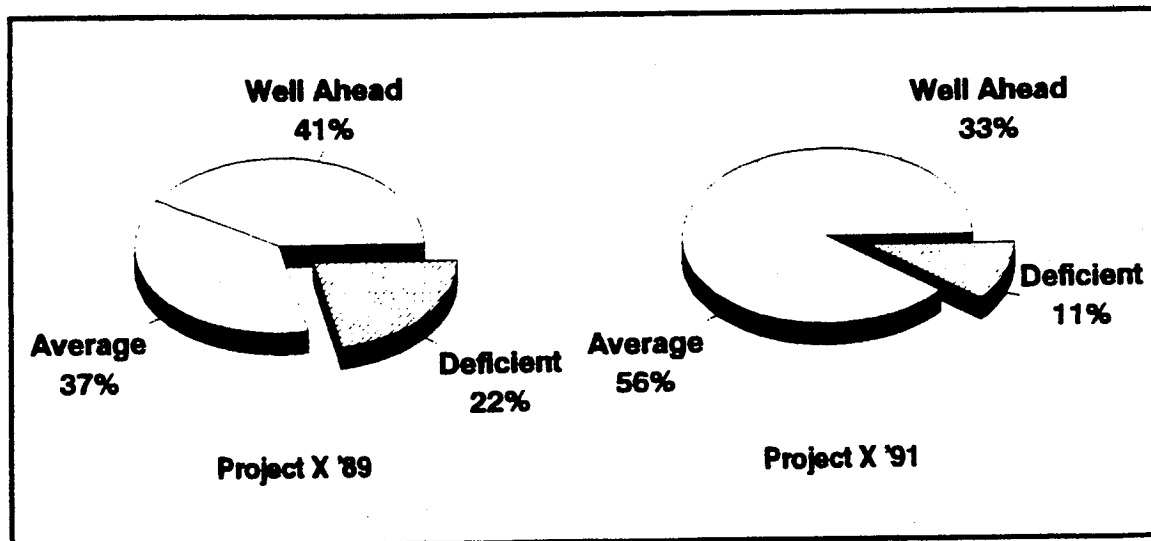

Figure 2

SUMMARY

This paper has described the use of the software process assessment program in AT&T, and demonstrated its value as an ongoing quality improvement tool for the software development community. AT&T will continue to encourage software organizations to participate in this program and to use the results to ensure that all software products achieve the highest levels of quality. Additionally, since good processes have been shown to correlate with higher levels of productivity and shorter intervals, it is in the best interest of the organization to strive for leading edge development practices.

References

1. Jones, Capers. *Programming Productivity.* McGraw-Hill, 1986.

2. Jones, Capers. *Applied Software Measurement.* McGraw-Hill, 1991.

3. Humphrey, Watts. *Managing the Software Process.* Addison-Wesley, 1989.

AT&T

SOFTWARE PROCESS ASSESSMENTS

Sharon Miller

George Tucker

Tony Verducci, Jr.

SOFTWARE PROCESS ASSESSMENT

OBJECTIVES

- Identify an organization's strengths and weaknesses

- Baseline the organization's processes against industry standards

- Compare the organization to others in AT&T

- Prepare a roadmap for improvement activities

SOFTWARE PROCESS ASSESSMENT

METHODS

	SPR	SEI
Basis:	Capers Jones CHECKPOINT™ Questionnaire	Watts Humphrey Capability Maturity Model
Focus:	Software Development Process Effectiveness	Software Development Process Management
AT&T Projects Assessed:	˜ 100 since 1987	˜ 40 since 1989

SOFTWARE PROCESS ASSESSMENT

PROCESS

- Planning
  - — Agreement on scope, schedule, cost
- Execution
  - — Questionnaires
    - SEI by management
    - SPR by development staff
  - — Consensus meeting for SEI questionnaire
  - — Facilitated meeting for SPR questionnaire

PROCESS (Continued)

- **Execution (Continued)**
  - Validation of SEI answers
  - Synthesis of results
  - Feedback to project
- **Follow-on**
  - Proposal (optional)

SOFTWARE PROCESS ASSESSMENT

CUSTOMER EXPECTATIONS

- **Commitments fulfilled**

- **Independence and objectivity maintained**

- **Strengths and weaknesses identified**

- **Feedback provided**

- **Confidentiality ensured**

- **Action planning available**

CUSTOMER FEEDBACK

- **Kiviat profile**

- **Strengths**

- **Weaknesses**

- **Project comparisons**

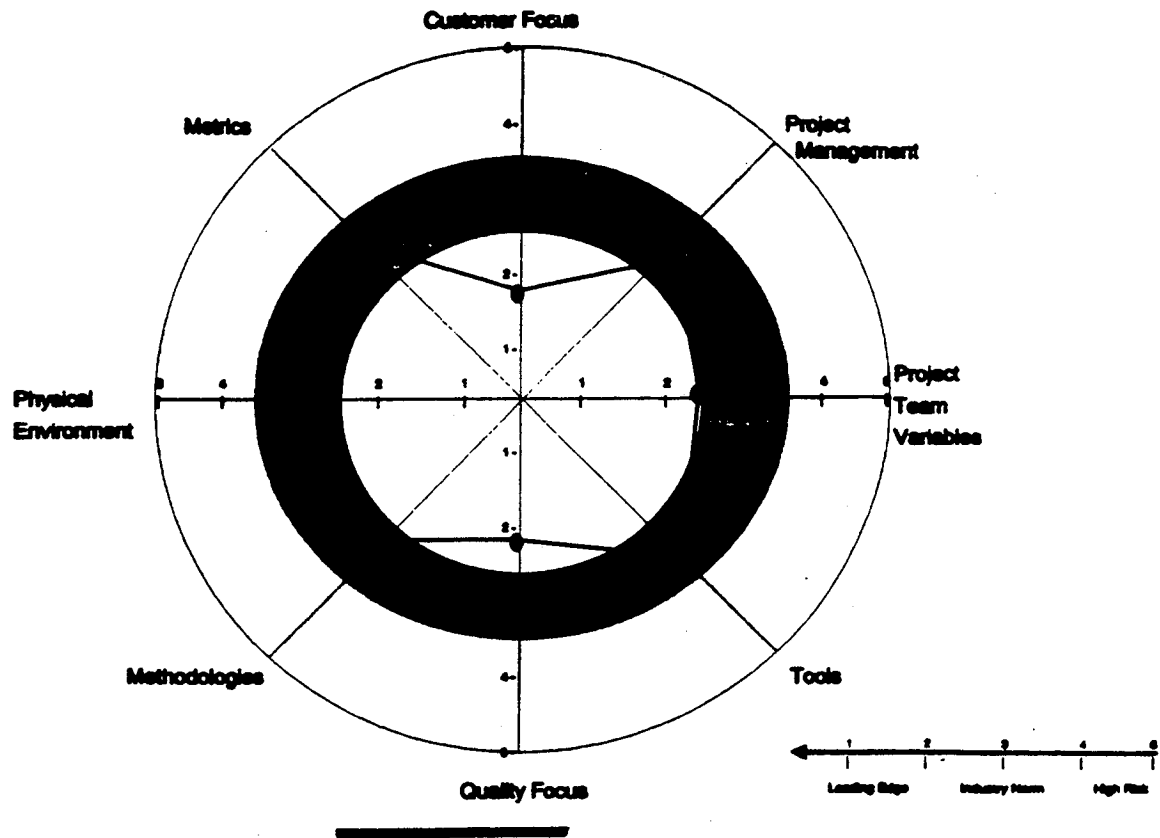- **Open-ended questions feedback**

SOFTWARE PROCESS ASSESSMENT

CUSTOMER FEEDBACK (Continued)

- **SEI maturity evaluation**

- **Project goals & constraints**

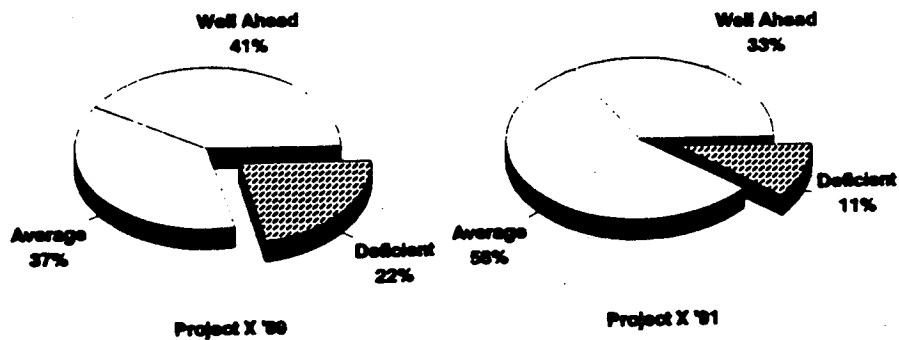- **Overall assessment findings**

- **Recommendations**

SOFTWARE PROCESS ASSESSMENT

SOFTWARE DEVELOPMENT PROFILE

SOFTWARE PROCESS ASSESSMENT

PIE CHART COMPARISONS

ROLE IN AN IMPROVEMENT PROGRAM

SOFTWARE PROCESS ASSESSMENT

↓

ACTION PLAN

↓

IMPLEMENTATION PLANS

Measurement of

Benefits (Reassessment)