

## Chapter 1

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# Why Do Assessments?

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### 1.1 What Assessments Do

This is a book about the theory and practice of process improvement assessments—how assessments work and what they accomplish. It focuses on software assessments because of the industry's by now extensive experience with them, but it also implicitly addresses the kind of systems and even hardware assessments that have recently evolved along the same lines. The book is meant to help managers and engineers understand what process improvement assessments aim to do and to help them think about what assessments provide in return for a substantial cost in time and money.<sup>1</sup> It is also aimed at instructing them in how best to prepare for an assessment and how to get the most out of it. Finally, it is intended as a guide for working assessors in the theory and practice of conducting assessments effectively.

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<sup>1</sup> For an exploration of the value of assessments, see *Why Do Organizations Have Assessments? Do They Pay Off?* [Dunaway 99].

## 2 CHAPTER 1 WHY DO ASSESSMENTS?

On one level, assessments can be thought of simply as tools for facilitating process improvement. They analyze the strengths and weaknesses of how an organization really works by examining its business, management, and engineering processes and their analyses and results can only be understood within the larger framework of the description of structured software development articulated by a sophisticated software improvement model. The most powerful of today's models are the SEI's Capability Maturity Model (CMM) and Capability Maturity Model Integration (CMMI), both of which emphasize the importance of detecting defects early and then preventing them. The process improvement initiated by these models involves an organizational discipline that recognizes and deals with problems early, accepts independent quality reviews, and promotes discomfort when quality procedures are missing.

But because increasing an organization's level of discipline involves changing people's expectations and motivating them to make appropriate adjustments at specific stages in the improvement process, assessments amount to more than strictly analytical procedures. They also function as instruments for organizational change. Assessments, which require an organization's active and willing involvement and which build on broad participation, are not the same as audits or external evaluations. The latter can be performed by outsiders, and they usually make insiders feel as if they are still in school and are receiving a report card.<sup>2</sup>

Because assessments are group efforts at self-analysis, they have the power to effect real improvement, and the crucial differences between assessments and audits have generated rules that are critical to an assessment's potential to motivate change. For example, one core aim of assessments is to fix problems, not people. Thus, assessments focus on how organizational structures work, not who did what in the past or who gave the

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<sup>2</sup> It is true that the CMM and CMMI are associated with auditing procedures for the cases that arise when an outside organization wants to evaluate the organization being audited for the purpose of, for example, deciding whether to use the organization as a contractor. These audits are called Software Capability Evaluations (SCEs) and SCAMPI/SCEs respectively and are treated briefly in Chapter 2. This book, however, is principally about assessments and will mention these other procedures only in passing.

assessors the lowdown. Interviews and the information they produce remain confidential. No statement made in an interview may be traceable to a given individual. These procedures result in a non-judgmental climate, which turns out to be crucial for helping to leverage an organization out of the dysfunctional patterns of a blame culture.

Because assessments are participant-based activities, they also help an organization “buy into” or “own” the improvement plans that come out of them. When proposals for change grow out of ideas generated by a collective effort rather than being imposed from above, people are much less prone to resist them.

But for organizations really to “own” the results of an assessment, the people in them must believe that an assessment has less to do with passing a test than with helping an organization get better at what it does. Audits evaluate organizations from without, which can be beneficial but is often discouraging. Because of the activities involved in the way they work, assessments help transform an organization into a more functional and more successful version of itself during the course of the assessment.

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## 1.2 The Four Principal Functions of Assessments

Assessments have four principal functions: They *analyze* how an organization really works, they (often through shock) help *motivate* it toward positive change, their procedures establish precedents that help organizations begin to *transform* themselves even before the assessment is finished, and they *educate* organizations by exposing them to best practices worldwide.

These four functions are of course not independent, nor do they always work the same way. Different assessment experiences can affect companies in different ways. Less mature organizations should prepare for the shock that accompanies realizing you aren't as good as you thought you were. They will be in for a strenuous educational procedure. On the other end of the scale, highly mature organizations (many of which will have already undergone previous assessments) usually experience

assessments as moments of concentration and careful self-analysis. But one never knows. No two assessments are quite the same in their impact or in their outcomes.

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Example: During a follow-on assessment, two groups within Organization A reacted very differently to the assessment experience. One group had long been with the organization and had been through several previous assessments. They had once responded defensively to questions and judgments, but they had also seen the progress that the first assessments enabled (in scheduling, the quality of their products, and customer satisfaction) and a corresponding improvement in their own work situations. During the current assessment, therefore, they were eager to assist the assessment team and take on new suggestions, even probing ones. A second group, however, which had recently been merged into the organization, had never experienced an assessment and did what first-time assessees usually do—cover their weaknesses and put the best possible face on everything. They tried to keep knowledgeable people from being interviewed, and they bridled when the draft findings suggested that the organization still had work to do to achieve the maturity level it expected. (Certain managers so feared the results that they found excuses not to attend the draft findings meeting.) Finally, senior managers associated with the first group stepped in. They did their best to explain to the newcomers that their reaction was counterproductive, and they also urged the Lead Assessor to make the final findings as clear and objective as possible—telling him, “Don’t hold anything back.” Both groups survived, but the first group experienced a very different assessment than the second.

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An assessment’s success, moreover, depends as much on the understanding and skill of the assessors as on the methods they employ. Analyzing a company depends on knowing enough about technical and managerial attitudes to ask the right questions at the right times while building confidence in the assessment process and in the future of the organization. Motivating

an organization toward improvement means emphasizing the positive effects of change. Educating an organization involves knowing the internal and often unspoken logic of process improvement methodologies and the international best practices out of which they grew.

### 1.2.1 Function 1: Assessments Serve as Analytical Tools

Assessments do not reflect the way the members of an organization *think* things work or the way the organization's paperwork says things theoretically *ought* to work. Based on separate interviews with staff at every level, they represent the way things really *do* work.

Assessments have taken the place of audits in the engineering community because audits have traditionally relied on a company's paper records of how things ought to work, whereas assessments rely on in-depth and cross-referencing interviews with practitioners that (whether or not the practitioners are happy to disclose it) get at how things really happen.

Assessments do not simply tell you the way one part of an organization works on its own. Instead they explain the way a part of the organization works within an organizational structure and an organizational culture, based on a sophisticated understanding of how the software development cycle works in the most successful companies around the world. An assessment's account of how an organization works is thus not merely descriptive. Assessment analysis depends on criteria established by a *reference model*.

Nobody likes the idea of being compared to a theoretical model. However, the models used by assessments are integrated global descriptions of how many good practices fit together, and assessments need to have a picture of the whole enterprise in mind, not just a catalogue of individual good practices. Assessment methodologies are never perfect, and they can sometimes even seem incomprehensible or perverse. But they remain the best available means of facilitating more productive, more reliable, and more profitable organizations. People apply assessments best when they understand their limitations, their logic, and their practical payoff.

### 1.2.2 Function 2: Assessments Function as Fulcrums of Positive Change

Assessments stimulate technical and organizational cultures to evolve. Seeing your organization as it really is can feel a little like being punched in the stomach. Managers always think their companies are better than they really are. No one is ever prepared for cold truth. But the *shock* of an assessment has priceless value because it can initiate momentum toward positive change. It dissolves complacency and enables staff to take a fresh look at how a company can be improved.

Shock alone, however, can lead to defensiveness and paralysis. Along with the shock, assessments put in place a group of mechanisms that help organizations survive the shock and work toward improvement in an open and energized way. Assessments convey the message that management is interested enough in making things better to take real action, bringing out the best in people who had become permanently discouraged. Assessments enable self-analysis to take place in a relatively penalty-free zone. Requiring broad participation, they distribute and limit exposure. Stressing that processes, not people, should be the focus of change, they diminish defensiveness. Providing a voice for change agents, they release energies that had been previously bottled up. Finally, assessments prioritize follow-on activities in an encouraging and logical way, making it easier to take the first steps toward new patterns of work.

### 1.2.3 Function 3: Assessments Transform Organizations by the Way They Work

When assessments work properly, the medium becomes the message and becomes self-sustaining. Assessments train and habituate organizations in continuing non-defensive self-criticism. The higher levels of maturity in assessment methodology represent nothing more than institutionalized and ongoing self-analysis. Assessments cannot work in a blame culture; therefore, for an intense moment, they condition the members of an organization to think about the pros and cons of what they do in a non-threatening way. Assessments also change people's perspective on their immediate environment and on

the larger environment in which they work, and these new perspectives have a way of becoming self-perpetuating. Finally, assessments require senior management to become actively involved in the improvement process, and this involvement almost always lasts beyond the end of the assessment.

#### **1.2.4 Function 4: Assessments Educate Organizations in Worldwide Best Practices**

By exposing a large segment of an organization's personnel to the best practices embodied in an assessment's capability maturity model, assessments not only motivate companies to improve, but they also teach them *how* to improve at a time when they are most receptive to learning new techniques.

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### **1.3 The Analytical Function of Assessments**

Assessment analysis depends not only on objective procedures but also on criteria established by a *reference model*. As we mentioned earlier, models are integrated global descriptions of the way that many good practices fit together and of the stages in which different good practices should be introduced so that they can build on each other, not compete or cancel each other out. That is, rather than being a catalogue of individual good practices, they involve the notion of maturity levels—a logical process of staged improvements.

#### **1.3.1 The Importance of Reference Models**

The core appeal of capability maturity models is that they promise a structured and therefore stable procedure to implement positive changes. The most important current software improvement models have been created by integrating the best practices of the most successful software development companies around the world into a step-by-step framework for implementing process improvement. At present, this means above all the capability maturity models developed since 1984 at the Software Engineering Institute—the CMM for Software [Paulk et al, 94] and the CMM Integration [Chrissis et al, 03].

### 1.3.2 Assessments Stabilize Process and Prioritize Change

The crux of the SEI-based assessment reference models is a vision of how organizations stabilize themselves so that random efforts toward improvement can evolve into structured, reliable, and continuous building of strength upon strength. For both the CMM and the staged version of the CMMI (see Chapter 2 for further details), five capability maturity levels are posited: Level 1 represents a condition in which processes are unarticulated and improvements are random and sometimes contradictory. At Level 2, project management processes are stabilized and articulated so that technical developments can be approached in a predictable way. At Level 3, the best project and technical processes are identified and institutionalized in an organization-wide platform so that the organization can centrally support improvement efforts, including training. At Level 4, both projects and the central organization begin to use baseline measurements to compare the strengths and weaknesses of past and current processes and products. At Level 5, the organization and the projects are able reliably to anticipate risk and bring in new technology with a firm grasp of the consequences of change, and to initiate programs of continuous improvement in a systematic and measured way.

In short, assessments analyze not just whether organizations perform functions well but also, in reference to a process improvement model, whether they are likely to reliably generalize lessons of continued and increasing excellence out of local successes.

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## 1.4 Assessments Function as Fulcrums of Positive Change

Assessments, though, do more than analyze. They act as fulcrums for positive change.

For process improvement to work, an organization must evolve, both technically and culturally. But change is exceedingly hard to produce. Assessments unleash important forces to move toward positive change. Consider Rosabeth Moss



Kanter's account of the change process. Laggards approach change, she suggests, with denial, then anger, then by blaming others, and finally by token efforts of acceptance, evidenced by cosmetic change. This last stage has been compared to "putting lipstick on a bulldog." It temporarily makes the bulldog look better, but it always makes the bulldog mad. The result in the long run is not substantive change but rather inevitable failure [Kanter 02].

Why do assessments succeed where other kinds of intervention fail? Assessments involve organizational staff as active participants in their company's evolution. After identifying areas of improvement, they facilitate a collaborative effort that feels like it has grown out of the collective experience rather than something that has been imposed from above or from the outside.

#### **1.4.1 Assessments Effect Change by Involving and Motivating Organizations in Efforts of Self-Analysis**

Assessment methodology requires a team to interview a broad selection of people, both managers and development staff, to provide representation across the assessed organization. Mitigating resistance, this broad participation fosters internal change.

You need to find out what's wrong with something before you can fix it. However, even in a problem-solving organization, the sudden exposure that accompanies real examination may cause people to feel frightened and stressed by having their work patterns examined: "When performance is measured objectively, you and your work can be seen by all" [Hammer 96]. It is not uncommon for this response to lead to the erection of self-protective walls, which serves as a major barrier to organizational improvement.

With the kind of broad participation required by an assessment, though, issues are shared, and turf protection either diminishes or becomes more obvious, in which case it can be dealt with directly.

Assessments also elicit specific, local response to possible avenues of improvement, reinforcing practitioners' sense that their experience and opinions are valuable. An assessment

provides a chance to respond not only for the members of the assessment team but for all the assessment participants who are interviewed over a long assessment process. Staff members are given a chance to shape the way improvements are proposed. They may recognize, for example, that new practices may not be valid for certain circumstances either in themselves or in the way that they are to be implemented. Imposing such changes by fiat makes workers want to throw out the baby (the principles behind the best practices) with the bathwater (the particular circumstances in which the practices are executed) and to respond negatively to the whole project of process improvement. When workers are allowed to consider a set of “best practices” in the context of their own understanding of how to make things better, though, they stop resisting them and start thinking of ways to make them work.

A positive approach to change is strongly associated with empowerment (decisions are made by people who know most about the issue regardless of rank) and collaboration (departments and functions work actively with other groups on a regular basis) [Kanter 01].

According to Boyett, “People don’t resist their own ideas. Our gurus agree that people who participate in deciding what will change and how things will change not only are more likely to support the change, but are actually changed themselves by the mere act of participation. ...Participation has become the standard method for accomplishing change and is a key feature of everyone’s change process” [Boyett 98].

In the words of Kotter, “Major change is essentially impossible unless most employees are willing to help, often to the point of making short-term sacrifices. But people will not make sacrifices, even if they are unhappy with the status quo, unless they really believe that a transformation is possible. Without credible communication, and a lot of it, employees’ hearts and minds are never captured” [Kotter 96].

Assessments provide a forum that helps focus general but unarticulated discomfort because people are encouraged to articulate problems and because the assessment team listens to everyone’s ideas empathetically and objectively. Assessments

thus provide a way to examine and address problems that may be collectively perceived, but not acknowledged. Frequently, it is heard at the conclusion of an assessment that “we didn’t learn anything new.” What people don’t realize however is that assessments allow old problems not only to be articulated but also to be addressed.

Assessments also force management to listen. Sometimes they hear what everyone except them seems to know. Sometimes they too know about problems but have no way to engage them without making them worse. Assessments require managers to acknowledge what everybody knows and to work with their employees on problem resolution. Assessments thus provide an arena for consensus between workers and management.

Finally, when an entire organization is involved in an assessment, those who have participated “own” the assessment results. Having been part of the analysis, they feel responsible for becoming part of the solution. This provides significant momentum for change.

#### **1.4.2 Assessments Effect Change Because They Help the Workers in an Organization Understand That Processes, Not People, Need to Be Fixed**

Because assessments are set up as non-threatening activities reinforced by non-attribution of information and the pledged confidentiality of everyone who participates, they say to all involved that the goal is to “fix the process, not the people.” Assessments make it very clear by their principle of strict confidentiality that it is not their business to “place blame” on individuals or projects. Their goal is to improve the organization’s way of doing business so that an environment is created for staff, managers, and customers that enables the production of a higher quality product.

Without confidentiality, asking organizational staff about the way they do their work could be intrusive and threatening. People could fear for their jobs and would be less than honest in expressing themselves. The entire assessment process would then be compromised.

That is why the procedures that an assessment uses to address an organization's process—not its people—need to be rigorously maintained. Strictly confidential assessment results are reported to the organization, and no specific person or project is identified with any of the assessment data collected. Each interview participant is also asked to keep confidential anything he or she may hear anyone say during the interview. The confidentiality also continues after the assessment is concluded. The assessment representative receives detailed data with all attribution removed. The assessment team members are asked to make a pledge of confidentiality, even after the assessment is over.

Sometimes concern arises that organizations need detailed identifiable data upon which to build improvement activities, but this concern is unfounded. After attribution has been removed, a large bank of highly detailed assessment data remains for improvement planning.

### **1.4.3 Assessments Effect Change Because They Provide a Voice for Change Agents**

In any organization, there are people who have come to recognize existing problems and have tried to convince their colleagues to improve.

The organization's staff usually has a good understanding of problem areas and may have already voiced their concerns, only to have their recommendations be dismissed.

The value of assessment findings is that they synthesize and document an organization's problems, presenting them with the authority of an organization's global view of its own processes. Assessments provide a focused statement of problem areas within the organization and identify instances of best practices that can provide solutions.

Also, because management sponsors the assessment, their attention is assured. Thus, good ideas get visibility, which boosts the morale of those people in the organization who have been trying to make improvement happen.

#### **1.4.4 Assessments Effect Change Because They Foster Follow-On Activities**

Assessments prioritize improvement activities according to the prescriptions of an elaborately thought out and structured process improvement methodology (a capability maturity model such as the CMMI, for example). This makes it easier to organize the plans that follow an assessment in a logical and highly structured way.

Assessments also constitute a very visible intervention that indicates to staff that the management is interested enough in improvement to take action.

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### **1.5 Assessments Transform Organizations by the Way They Work**

Because assessments involve a broad section of the organization in a rigorous and communal act of self-analysis, they help train organizations to be systematically introspective and self-critical. The model of best practices against which the organization is evaluated provides guidance, but the ways in which best practices are introduced to the organization in the assessment create a basis for transformational effectiveness. Assessments force people to see things in more useful ways, and these new perspectives become self-sustaining: They perpetuate themselves after the assessment has been completed and make organizations more analytical and more efficient.

#### **1.5.1 Assessments Transform Organizations by Getting Different People to See the Same Things the Same Way**

A key part of the self-analysis that occurs during an assessment involves an organization's insight into how it is doing business at the moment of the assessment. This might seem like an obvious statement, but it is not, particularly in an organization that takes an ad hoc approach to improvement. When practitioners in such organizations begin to document the way they do

business, they are often surprised and nonplussed. Often there is inconsistency or confusion about the way things are done. Identifying the current processes they use becomes a valuable exercise in its own right. The assessment imposes the discipline of objectivity onto a culture of wishful thinking: It examines the way things are being done at that particular point in time—not the way things should be done, or the way someone wants them to be done. The insight is the equivalent of finding your present location on a map so that you can intelligently plot a path to your goal. As Watts Humphrey once famously remarked, “If you don’t know where you are, a map won’t help.”

### **1.5.2 Assessments Transform Organizations by Helping Senior Management’s Efforts at Unification**

Next, an assessment necessarily requires that senior management be actively involved as the sponsor of the assessment and the source of actions implemented as a result of the assessment. This also frequently constitutes a major shift in the operations of the kind of low maturity organization in which software is viewed as a mysterious process to be pawned off to a software department that may have little real authority. Without the sponsorship of senior management, grass-root efforts don’t get results and become frustrating for the work force. Assessments require senior management to say that the process improvement exercise is being conducted not just for the software department’s sake but also for the organization’s sake.

Deming and Humphrey have indicated that major changes within an organization require leadership [Deming 82] [Humphrey 89]. Senior managers must set challenging goals and monitor their progress. Assessments require managers to establish priorities, provide resources, and monitor and support the changes in the software process. With management’s hands-on involvement and support, grass-roots efforts begin to flourish. Assessments help transform an organization into a unit in which continuous management support becomes a prominent and lasting feature. Management commitment does not simply mean giving approval. It includes providing direction, having a good understanding of what and why activities are being undertaken, and providing visible active support and encouragement.

### **1.5.3 Assessments Transform Organizations by Softening a Culture of Blame, Permitting Staff the Freedom to Think About What Goes Wrong and How to Correct It**

Another way that assessments transform organizations into better places to work is the way that they condition the members of an organization to think about the pros and cons of what they do in a non-threatening way. By insisting on the strict maintenance of confidentiality for all interviews, an assessment establishes a non-judgmental, respectful attitude toward the views of all the people who are interviewed. Non-attribution of data is essential for a free flow of information from participants in an assessment, but it also helps soften and transform organizational practices and begins to create better working environments.

Part of becoming a more mature organization involves recognizing that everyone makes mistakes and that the sooner you find the mistakes and their causes, the more profitable the company can be. As Stan Rifkin puts it, "There is no doing without mistakes. [The real question is:] What is the company's response? In the world of action mistakes are inevitable. Organizations that have closed the knowing-doing gap treat mistakes as a natural part of doing and use the mistakes as occasions for learning. Surgeons call this 'forgive and remember!'" [Rifkin 03].

### **1.5.4 Assessments Transform Organizations by Encouraging People to Think Across Boundaries**

Assessments encourage participants to think across boundaries that may exist in the organization. Programmers learn how requirements experts think. Technical people learn how managers think. People on different projects learn how the other parts of the organization think. All in all, the experience helps everyone to feel as if he or she is part of an organization with mutual interests instead of competitors for resources or recognition. This is no small thing.

Nor is thinking across boundaries just a matter of what the other guy is doing. Different parts of the organization may have

a certain way of thinking about quality, for example, even if they are doing similar jobs. The give and take of assessments helps them to question their own deeply held assumptions about what works and what doesn't work and opens them up to other and perhaps better ways to do things.

### **1.5.5 Assessments Transform Organizations by Consolidating a Party of Improvement**

Conversely, people in different parts of an organization may have common doubts about the way things are done and common suggestions for how to make processes more reliable and more efficient. But because they are compartmentalized, their doubts are often dismissed. Assessments allow such people to confirm their own intuitions and unite to form a force for positive change. This happens not only as a product of a post-assessment action plan but also as a side effect of the assessment meetings themselves. And it can transform a culture.

### **1.5.6 Assessments Transform Organizations by Helping to Institutionalize Rigorous Analysis**

Finally, assessments involve inculcating the plateau-sensitive logic of planned process improvement into company planning. There are many ways that an organization's action planning team can prioritize the introduction of improvements. But in immature organizations, few of them are sensitive to the knowledge contained in process improvement models about what software development processes must be in place before others can reliably function. Assessments integrate into an organization's own process of self-analysis an understanding of what software process improvement levels call *maturity levels*—that is, an awareness that unless management practices are made more predictable (the work of Level 2 in the CMMI), then sophisticated improvements in the organization's technical practices often will not work.



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## **1.6 Assessments Educate as They Analyze, Motivate, and Transform**

### **Assessments Educate by Giving People in Organizations a Broader Knowledge of Their Own Company and by Encouraging Organizations to Contemplate Industry's Best Practices and Compare Them to Their Own**

Assessments involve perhaps dozens or even hundreds of an organization's employees, many of whom have only a vague idea of how what they do is done on other projects in the same organization, much less in other organizations around the world. When they are required to compare their own practices to the ideals of an assessment model, however, and to listen to how their fellow employees' practices also relate to that model, they begin what may be a transformative education in the field of their expertise.

The venue and framework of this educational process, moreover, is as important as its content. Assessments force people to think hard about the pros and cons of what they do. It is in the midst of this rethinking that they encounter other ways of doing the same thing—at a moment when they are uniquely receptive to alternative procedures and in an atmosphere that is structured to be non-punitive about past performance.

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## **1.7 Why Gaming the Results of an Assessment Doesn't Help (Though Many Try)**

The trigger for assessments quite often comes from an outside organization or from a higher level of the same company or corporate group. The need to achieve a maturity level frequently seems as if it has become a criterion for doing business. As a result, organizations are sometimes dragged into assessments against their will and naturally respond by an attempt to "game" the assessment—to represent the organization as functioning at a higher maturity level than is really the case.

The bulk of this chapter should have already demonstrated that this is a perversion of the assessment process—a process aimed at helping to motivate organizations to improve themselves, which can only be accomplished with an honest effort. Organizations may in the short term fool an authorizing agency, but in the long term, they only cheat themselves, in the process discouraging their quality motivated personnel and making efforts at real improvement much harder after their deception is recognized. Chapters 4 through 11 of this book contain numerous examples of how companies unsuccessfully tried to “game” better results. It can all be summed up very simply: “Gaming” leads to nothing more than frustration, and it damages more than it helps.

Organization A exerted every effort over eight years to position and distort the results of numerous assessments. It tried to dismiss every honest assessor and derail every objective assessment, and it eventually succeeded in arranging to be audited rather than assessed. It then doctored its documentation and tutored its personnel in what to say. The audit certified that it was a “Level 5 Organization,” and the organization’s manager was over the moon. Less than a year later, however, corporate headquarters realized that Organization A was still producing products of inferior quality—over schedule and over budget—and reassigned all of its projects. The organization wasted many years and millions of dollars that might have turned it into a first-rate software house to achieve a false certification—and ended up with nothing. The manager of Organization A is now looking for another job.

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## 1.8 Can Assessments Really Change an Organization? A Preview of an Extended Case History to Be Found in Chapter 12

Chapter 12 supplies an elaborate case history of the way that a program of reiterated assessments not only improved the maturity level of the software division of a major defense company ("Organization Z") but also made it a more efficient, happier, and more profitable place to work. That transformation may be briefly summarized according to the four principal functions of assessments provided previously.

### 1.8.1 Analysis

The *analytical* power of a Level 3 assessment demonstrated real gaps between Organization Z's perception of its own processes and the way those processes really operated. For example, the assessment revealed problems with the organization's information and authority structures that involved project managers who had in effect absolved themselves of responsibility for software issues and software managers who were unaware that their engineers were not using the company's software processes. The assessment encouraged these problems to be addressed and rectified, and a second assessment encouraged Organization Z to utilize its reorganization to exploit the power of quantitative management and to create feedback loops for continuous improvement.

The force of these analyses derived not just from the assessment's power to probe issues that the organization could confront on its own, but also from an integrated vision of how software operations ought to work provided by the assessment's reference model.

### 1.8.2 Initiation of Positive Change

The shock of Organization Z's first assessment made its executives and project managers reevaluate the organization's management structure. That shock enabled the organization to reorganize the way one level of management reported to the

next. After the first assessment, the President of Organization Z came to use his own authority to redress the organization's problems. But he did so principally because the need for the improvement was conveyed during the assessment by the organization's full ladder of personnel, middle managers, and executives. Many of these people already knew what was wrong before the assessment, but it was the assessment itself that consolidated their energies in the direction of positive change.

### 1.8.3 Positive Transformation

The structural transformation undertaken by Organization Z began with the procedures imposed by the assessment itself. Conducted in a way that related each project to the organizational and administrative capabilities of the entire group, the assessment launched Organization Z into a full rethinking of how its different parts and functions related to each other.

### 1.8.4 Education

None of these advances would have proceeded without the artificially intense education that the organization had received during a series of assessments—an education that synthesized and transmitted the current state of software practice.

Organization Z chose to change when it recognized the deficiencies of its own operation in relation to other, more successful software operations around the world. The organization's personnel had been shocked, and their ways of thinking had been transformed, but ultimately it was the taste of increased success and the lure of a more profitable operation that motivated them to improve.

### 1.8.5 A Continuous Program of Assessment and Improvement

Organization Z's improvement finally was facilitated not by a single assessment but by the organization's decision to begin a cyclical program of assessment and improvement. In this process, the second and each subsequent assessment and health check functioned not as wake-up calls but rather as exercises in

course correction. All of them reinforced the improvements already under way at the same time that they communicated a sense that new improvements would extend initiatives undertaken in the first cycle.

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## 1.9 Bottom-Line Profit and Cost Numbers: Assessments Pay

How much did Organization Z save by this process of reiterated assessments?

At its most basic level, process maturity creates an organizational discipline that finds and fixes defects early and then ultimately prevents them. The cost benefits of this kind of process maturity improvement may be simply calculated:

A typical software development project injects approximately 100–250 defects per thousand lines of code [Humphrey 02].

- 1 defect found early in development costs \$100 to \$200 to fix.
- 1 defect found in the testing stage costs \$1,000 to \$2,000 to fix.
- 1 defect found during operations costs \$10,000 to \$20,000 to fix. [Bush 02]

Today's development expectations for a Level 1 organization count on at least three to six operational defects per thousand lines of code. The fixing of these alone translates into unnecessary costs of between \$30,000 and \$120,00 per thousand lines of code.

Not finding or preventing defects before testing, though, can be almost as costly. A Level 1 organization is lucky to find 25% of defects before test, whereas a Level 3 organization typically finds 50% of defects before test, and a Level 5 organization finds between 75% and 80%. A Level 3 organization can thus easily save \$30,000 per thousand lines of code, and a Level 5 organization can save \$60,000 per thousand lines of code.

Many projects now produce programs consisting of 250,000 to one million lines of code, and the programs are getting more complex all the time.

Bottom line: Process maturity can translate into hundreds of millions of dollars of preventable costs.

Case in point—When Organization Z progressed over four years from a Level 2 to a Level 5, it reported, among other benefits, a gain in software productivity costs of 47% and an increase in customer satisfaction of 9% per year. These percentages can be easily translated into dollars by looking at the organization's history of finding and fixing defects.

At Level 2, Organization Z found 50% of its defects before testing, but after four years of assessments and improvements, that figure rose to 75%. As a result, Organization Z saved \$4,542,000 in development costs over these four years, not including the positive ripple effect into other departments.

This was of course not all profit. Organization Z spent a total of \$3,138,000 for software improvement costs over the four years, including assessments but also including training and new software improvement practices. (\$1,956,000 of this in fact went for the cost of administering Fagan Inspections.)

The results are still startling. The numbers work out to a total return on investment of software improvement costs of \$1,404,000 over four years—\$350,100 per year—or in percentage terms, a return of 44.6% per year.

In a larger picture, as a percentage of Organization Z's total software development budget of \$14,000,000 per year, the same figure represents a net increase in profit of 2.5%.

Nor were Organization Z's bottom line numbers extraordinary. Organization Z was a better-than-average company, producing high-quality software to its customers, though sometimes behind schedule and over budget. Companies with more problematic records benefit even more dramatically from software improvement efforts.

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