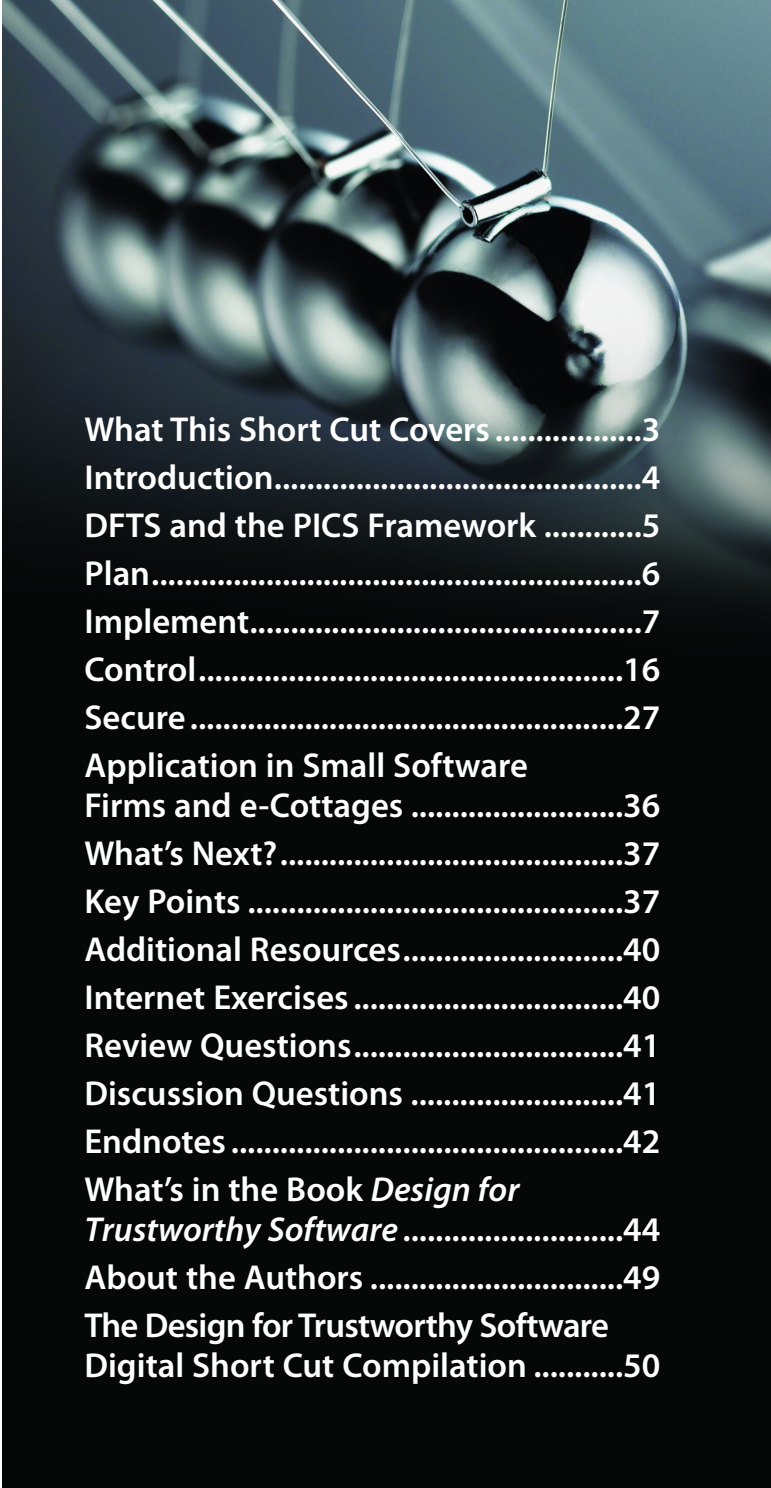# shortcut

The Design for Trustworthy Software Compilation

Launching a Design for Trustworthy Software (DFTS) Initiative

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several months in an enterprise software context. This is a process of action learning in that the team learns not only in the classroom but also during the actual software development process (see Figure 3).

A defining aspect of the DFTS learning process is the practice of self-appraisal, successive appraisal, and review of work carried out to date with the customers. This ensures that customer needs are understood as they evolve throughout the development process. The customers are kept abreast of the state of the development process, thus avoiding costly surprises and revisions. Here customers are not only external but internal—the next people in the development process.

Control

Step 13 constitutes control activities in the PICS framework. At a minimum, control systems in a DFTS process involve monitoring of and feedback for variations in process and software product quality for taking necessary corrective actions (see Figure 1). But in a larger organizational context, a solitary control mechanism such as these would hardly be effective, especially if DFTS is meant to be a key element of an organization's overall competitive posture. Simons, in his landmark work *Levers of Control*,

proposes a system of four control constructs to successfully implement a competitive strategy:[4]

1. **Belief systems** are an explicit set of values, beliefs, and purposes as expressed in mission and vision statements, credos, and statements of purpose. Commitments to customers, employees, and other stakeholders have to be clearly stated and practiced for them to be credible. They provide stability, character, and strength to organizations and serve them especially well in turbulent times and times of crisis. Johnson & Johnson's famous credo, listed in Figure 4, has been an anchoring influence for the company. It has changed little since it was penned by Robert W. Johnson, Jr., in 1943. It places responsibility to stockholders last; doctors, nurses, patients, and their families, employees, and the community all precede it. In more recent times, corporate leaders such as Medtronic's Bill George have argued against the futility of maximizing shareholder value as a sustainable strategy. He states, "Motivating employees with a mission and a clear sense of purpose is the only way I know to deliver innovative products, superior service, and unsurpassed quality to customers over an extended period of time. Over time, an innovative product or a service will be copied by your

competitors. Creating an organization of highly motivated people is extremely hard to duplicate."[5] Emphasizing customer and employee interests above stockholder return as a sound corporate practice is a recent trend in corporations globally. The Indian IT software outsourcing provider Infosys Technologies, which makes a lot of money for its stockholders, does not even mention stockholder interests in its mission statement while including clients, employees, vendors, and society at large (see Figure 5). Belief systems invariably transcend particular initiatives or performance cycles. They direct the behavior of senior executives seeking new opportunities or facing strategic choices that may alter an organization's course. Although belief systems constitute the most powerful control mechanism, their true significance is probably least understood.

2. **Boundary systems** are formally stated sets of rules, limits, and proscriptions tied to defined sanctions and credible punishments. Such control mechanisms consist of codes of conduct, strategic planning systems, asset acquisition systems, and operational guidelines. These are meant to help senior executives in their conduct on issues involving the organization's reputation. They also define strategic boundaries to protect resources in opportunity-seeking behavior.

3. **Diagnostic control systems** measure and monitor outcomes to correct deviations from preset standards of performance as expressed in budgets, best practices, standards, goals, and metrics. The preset standards are set by senior executives or are negotiated between senior executives and those who report to them. To be effective, these standards must be based on the collective understanding of the beneficiaries of the outcomes, such as customers and other stakeholders. In a DFTS context, measures such as Cost of Software Quality (CoSQ) and Software Quality Metrics monitor process and software product quality. These are fed back upstream for corrective measures, as shown in the PICS framework (see Figure 1).[3]

4. **Interactive control systems** require regular and personal involvement of managers in the subordinates' decision activities. Such systems include project management systems, customer appraisal and review, and profit planning systems. Such
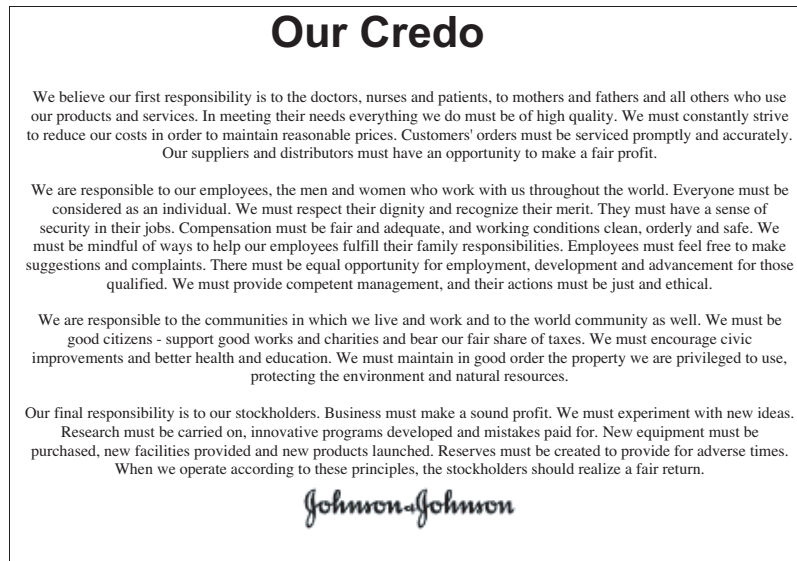
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[3] Chapters 3, "Software Quality Metrics," and 4, "Financial Perspectives on Trustworthy Software," in Design for Trustworthy Software by Jayaswal and Patton, published by Prentice Hall have more information about process and software product quality monitoring.

systems ensure that managers remain engaged and that the discussion is based on real and validated data that constitutes the agenda of discussion between managers and subordinates: the essence of fact-based decision making.

Another set of control mechanisms, internal control systems, are not used by managers to control strategy.[6]

Our Credo

We believe our first responsibility is to the doctors, nurses and patients, to mothers and fathers and all others who use our products and services. In meeting their needs everything we do must be of high quality. We must constantly strive to reduce our costs in order to maintain reasonable prices. Customers' orders must be serviced promptly and accurately. Our suppliers and distributors must have an opportunity to make a fair profit.

We are responsible to our employees, the men and women who work with us throughout the world. Everyone must be considered as an individual. We must respect their dignity and recognize their merit. They must have a sense of security in their jobs. Compensation must be fair and adequate, and working conditions clean, orderly and safe. We must be mindful of ways to help our employees fulfill their family responsibilities. Employees must feel free to make suggestions and complaints. There must be equal opportunity for employment, development and advancement for those qualified. We must provide competent management, and their actions must be just and ethical.

We are responsible to the communities in which we live and work and to the world community as well. We must be good citizens - support good works and charities and bear our fair share of taxes. We must encourage civic improvements and better health and education. We must maintain in good order the property we are privileged to use, protecting the environment and natural resources.

Our final responsibility is to our stockholders. Business must make a sound profit. We must experiment with new ideas. Research must be carried on, innovative programs developed and mistakes paid for. New equipment must be purchased, new facilities provided and new products launched. Reserves must be created to provide for adverse times. When we operate according to these principles, the stockholders should realize a fair return.

Johnson&Johnson

Courtesy of Johnson & Johnson. Reproduced with permission.

FIGURE 4 The Johnson and Johnson Credo

Infosys' Vision, Mission and Values

Vision

"To be a globally respected corporation that provides best-of-breed business solutions, leveraging technology, delivered by best-in-class people"

Mission Statement

"To achieve our objectives in an environment of fairness, honesty, and courtesy towards our clients, employees, vendors and society at large"

The values that drive us: C-LIFE

- **Customer Delight:** A commitment to surpassing our customer expectations.

- **Leadership by Example:** A commitment to set standards in our business and transactions and be an exemplar for the industry and our own teams.

- **Integrity and Transparency:** A commitment to be ethical, sincere and open in our dealings.

- **Fairness:** A commitment to be objective and transaction-oriented, thereby earning trust and respect.

- **Pursuit of Excellence:** A commitment to strive relentlessly, to constantly improve ourselves, our teams, our services and products so as to become the best.

FIGURE 5 Infosys's Belief System (http://www.infosys.com/about/vision_and_mission.asp)

However, they are fundamental in ensuring the integrity of data used in strategic control systems. It is therefore essential that those responsible for the organization's internal control systems also be involved in safeguarding the integrity of DFTS process and quality data, especially CoSQ and other financial data.

Finally, the process has operational controls. These are accomplished through *feedback control systems*, which are an integral part of the PICS framework, and through *project management*, which has its own control mechanisms. Organization-wide control systems are beyond the scope of this book. We will discuss feedback control systems and project management in a DFTS context.

Step 13: Feedback Control Systems

This is a crucial element of the PICS framework and is the equivalent of the "check" phase of Deming's PDCA Cycle (Deming called it the Shewhart Cycle).[7] If you fail here, the whole process becomes erroneous and out of control. It therefore must be designed to operate well. A reliable feedback control system provides appropriate measures of key variables in a time- and cost-effective manner for learning the state of the development process and for taking subsequent corrective and improvement measures. The variations are measured from product as well as process appraisal and involve both internal review and interaction and appraisal with customers, both internal and external. These constitute a major learning opportunity for improvement and may consist of a cycle of review

meetings and corrective measures. Such a mechanism is effective if it is an ongoing activity of continuous learning and improvement year after year until the initiative is effectively internalized as part of an organization's culture.

Case Study 1 illustrates GE's Operating System, which has proven to be a powerful tool for continual appraisal and enrichment. It transforms initiatives across several dozen businesses rapidly such that all the initiatives become operational across the company within one month of launch and produce positive financial results within their first cycle. GE's various initiatives undergo successive cycles of year-round review and enrichment through its Operating System. By 2002, Globalization had been enriched through more than a dozen cycles, Six Sigma had gone through five cycles, Product Services had gone through six, and e-Business had gone through three.[8]

We propose a DFTS feedback review framework as part of the control mechanism, as discussed next.

Elements of DFTS Feedback Control System

Using multiple performance measures, financial and operational, was proposed by Kaplan and Norton in

"The Balanced Scorecard."[9] The DFTS feedback control system, shown in Figure 6, must be designed to measure variables that are important, measurable, and actionable. They must provide visibility of process and products meeting five sets of objectives (as you will see, they are interrelated): *learning and teaching capabilities*, *CoSQ capabilities*, *customer satisfaction*, *process robustness*, and *improvement opportunities*. Here are some important questions they help address:

▶ **Learning and teaching capabilities:** Do we understand the DFTS process well and feel comfortable using it? Are we developing a required internal teaching infrastructure and resources to improve and expand it? If not, why not? What can be done to improve our learning and teaching capabilities?

▶ **CoSQ capabilities:** Are we measuring the cost of poor quality accurately throughout the software development cycle? (See Figure 2.) Have we developed capabilities to use such information correctly? If not, why not? How can we improve our CoSQ capabilities?

▶ **Customer satisfaction:** Have we specifically met the customer's cost, quality, and delivery schedule, as measured by relevant metrics? Have we exceeded them or fallen short? If we haven't succeeded, why not? What can we do to improve customer satisfaction?

▶ **Process robustness:** How capable is our DFTS process, as determined by a process feedback loop, in meeting stated and unstated customer requirements, as determined by CAR? What opportunities have been identified to improve our use of various tools, techniques, and methodologies that constitute DFTS technology? What steps should we take to improve the process capability before integrating the revamped DFTS process and expanding it further? How can we improve our DFTS process capabilities?

▶ **Improvement opportunities:** What are further opportunities for improvements, identified from internal idea generation and emergence of best practices, and as measured by the gap between customer needs and process performance? (Process capability improves as the gap diminishes; this also implies less room for improvement.)

Requirements:

Metrics

Improvement Opportunities

Process Robustness
Requirements:
Metrics

Customer Satisfaction
Requirements:
Metrics

CoSQ Capabilities
Requirements:
Metrics

Learning and Teaching Capabilities
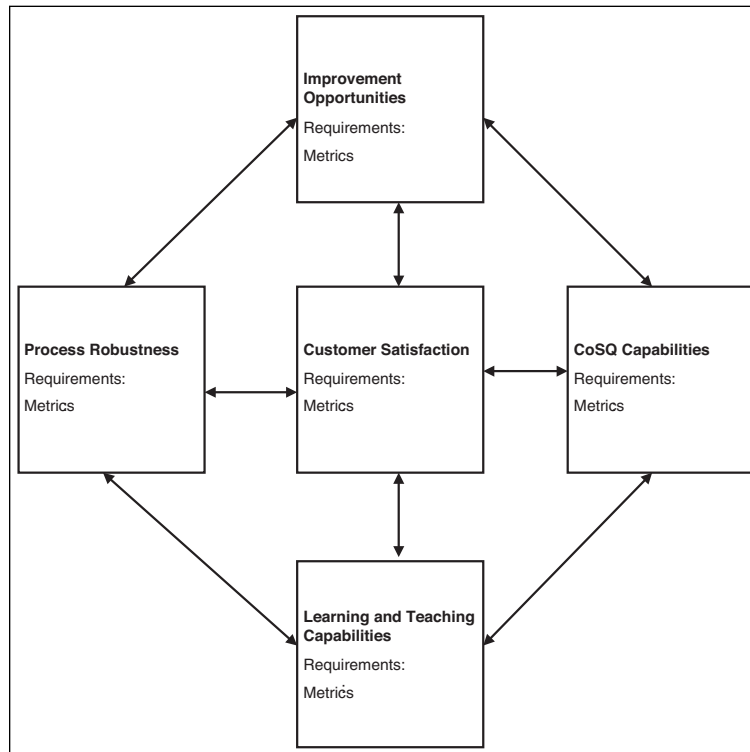Requirements:
Metrics

FIGURE 6   Elements of Feedback Control Systems

Establishing a Feedback Control System

Control systems essentially provide visibility on cost, quality, and other measures of performance. They often become sociopolitical in nature because the people involved may feel insecure or perceive a loss of power as a result of such visibility of their performance. A feedback system therefore must have the support of the CEO and top management to be viable. Another problem with such systems is that although they have been in use for all kinds of control purposes, they are not always perceived and designed well. The system should be developed by a team assigned by the DFTS steering committee. For any control system of this nature to work, it must be customized. Establishing the DFTS feedback control system involves the following steps:

1. Obtain management commitment and support.

2. Obtain the cooperation of users and other stakeholders.

3. Establish a development team.

4. Identify control system requirements and measures (see Figure 6).

5. Determine sources of data.

6. Establish procedures to collect data.

7. Design control system reports.

8. Collect data and conduct control runs.

9. Eliminate bugs from the system.