

**TOWARD EFFECTIVE CORRECTIVE ACTIONS
FOR PROGRAMS AND PROCESSES**

Constance Perin, PhD

Visiting Scholar, Program in Science, Technology, and Society
Massachusetts Institute of Technology
77 Massachusetts Avenue, E51-185
Cambridge, MA 02139-4307
phone 617/621-1331 fax 617/621-1347 E-mail cope@mit.edu

Writing recommendations for corrective actions that make a lasting difference depends on having reliable knowledge about the envelope of conditions surrounding an event. In addition to the specific conditions at the time reported by those involved, there is also knowledge about, for example, maintenance history, component performance trends, and processes for work scheduling and work package preparation. These make up the evidence used in root cause analyses, which are the basis for recommended corrective actions.

Some recommended corrective actions may, however, not be implemented at all or may not be effective in preventing a similar event or incident. Corrective actions for design modifications or component replacements and repair are more likely to be enacted than are those concerning station processes and programs. As I understand it from studying event review team activities, process and program recommendations may not be implemented or effective, partly because the kinds of knowledge they require is harder to get, which makes it harder to foresee – and justify – their effectiveness. This seems to be widespread, despite the industry's acceptance of the concept of "error-forcing conditions," which relate directly to programs and processes. These conditions consist of the "aggregate of all management and leadership practices, values, culture, corporate structures, processes, technology, resources and controls that combine to result in the currently existing conditions which affect behavior of individuals at the job site" – quoting from the definition in the *NEI/INPO/EPRI Industrywide Human Performance Process Benchmarking Report* (May 2001, p. Z-4).

The NRC's emphasis on cross-cutting issues, self-assessments, and corrective action programs raises a new question: How to develop an approach that relates the details of events to specifics of that "aggregate of all management

and leadership practices”? What seems to be needed is a way to develop effective corrective actions for the processes and programs that “aggregate” affects, which are also more amenable to justification.

In the spirit of a thought-experiment, this paper sketches out some of the issues this new question raises.

Sources of Error-Forcing Conditions

What produces error-forcing conditions and what kinds of knowledge and analysis are needed to write and justify corrective actions that stand a good chance of being effective? Error-forcing conditions are likely to be “annunciators” of deeper-lying issues. Here, for example, are some of the specific conditions that event review teams may point to as “contributing or aggravating” or as “error-forcing”:

- schedule pressure
- non-conservative decision making
- inadequate pre-job briefs
- inadequate work package reviews and walk-downs
- mis-communication or lack of communication and coordination
- managers’ misunderstandings of technical issues
- ambiguous procedures
- competition among departments for resources
- “tunnel vision,” “group-think”

The recommendations relating to programs and processes are likely to fall into such categories as:

- revise procedures
- re-train
- change schedule for component inspections
- improve communication and coordination
- reiterate managerial expectations

But do such corrective actions go beyond the “annunciator” to locate its source? Another question needs to be answered: Why has the need for these improvements arisen in the first place?

Consider the possibility that error-forcing conditions are outcomes of choices entailed in all that the *Human Performance Process Benchmarking Report* defines as “organizational factors.” The sources are, I propose, what I call *structuring choices* that have been made, or, events may reveal, need to be made. Managers make these choices out of a range of possible approaches to enabling and maintaining a well-functioning enterprise. A random list:

- affirming executive control....enabling lateral coordination and cooperation
- rewarding teams....rewarding individuals
- priority to system training....priority to component training
- designating “safety” as function....integrating ”safety” within functions
- adding or reducing technical and social complexity
- relying on the home team.....depending on contractors
- rewarding professionalization....emphasizing rule-following
- assigning high responsibility with low authority or influence
- acknowledging interdependencies....encouraging departmental competition
- recruiting generalist managers....phasing out technical managers
- favoring blaming....requiring explaining

The choices managers arrive at reappear in allocations of time, money, and people, work system design, processes and forums for communication, collaboration, and conflict resolution, as well as in priorities and in systems of incentives and sanctions, for example. They may make their choices with an eye to consistency and complementarity, but as can be expected in complex enterprises, the choices’ impacts and consequences may, once in practice, turn out to contradict or conflict. Each choice nevertheless structures the contexts of operational practices; each choice shapes programs and processes fundamental to the strategies and tactics of risk-reduction.

Utility, station, and plant managers face such choices, often more than once. They may or may not include in their deliberations those who are not also managers. But what they are unlikely to do, nor routinely be asked to do, is to make explicit the criteria, values, rationales, priorities, beliefs, constraints...informing their choices. All those responsible for operational activities live, in any case, with their consequences.

To write corrective actions that prevent unwanted or unintended consequences, the rationales behind the structuring choices need to be understood, in order to consider whether they need to be re-visited. This knowledge – this self-knowledge of decision rationales – is central to developing effective corrective actions for programs and processes.

Two Kinds of Logics

The kinds of knowledge and reasoning needed to write corrective actions that directly affect mechanical and material conditions differ from those needed for writing corrective actions for programs and processes. Equipment and structure-related corrective actions depend on knowledge and reasoning derived from engineering practices and statistical analyses embedded in technical specifications

and the design basis, for example. Corrective actions for programs and processes depend on the kinds of knowledge and reasoning represented in the range of specialists every utility and station must have – some of it discipline-based knowledge and reasoning, some of it experience-based, some of it amenable to statistical analysis, some based on “best estimates” derived from observation and from benchmarking exercises, but all more a matter of judgment, values, foresight, and priorities than of a tested formula or “magic” number.

The algorithms, equations, and models of technical specifications assure control over mechanical, material, and physical forces. I call these *formal logics*: they use engineering knowledge and reasoning to specify the performance of structures and systems within quantifiable limits. Models for electricity production similarly rely on formalizations of efficiency and optimization based largely on operations research concepts and techniques. These models produce quantitative estimates of output and of financial costs and benefits over time. Formal logics generate predictive control systems whose consequences for reducing risks during operations and for productivity are measurable and, to some extent, verifiable. The same logics generate operating procedures and rules.

Plant operators (meaning all specialists, up and down the ladder, who contribute to electricity generation) also rely on particular kinds of knowledge and reasoning to guide risk-reduction strategies, which I call *substantive logics*. They are substantive because they represent knowledge about, informed interpretation of, and insight into interactions among the historical, social, and cultural dimensions of operations and production – a different but no less relevant scope of knowledge, concepts, reasoning, and language.

Formal logics predict, within limits, the interactions of parts-to-parts, assemblies-to-assemblies, machines-persons interactions. The numbers they produce result in prescriptive and normative rules: how machines and people and machines should and ought to work together. Substantive logics take context into account and, no less rule-oriented, further assume that rules may have to be conditional and contingent – hence the rule for stopping a job to initiate a procedural revision, for example. Formal logics are applied to experience, while substantive logics are derived from experience. Formal logics universalize and generalize; substantive logics specify and particularize practices and processes and interpret their wider significance, context by context.

Steps Toward Effective Corrective Actions

Developing an approach to putting these ideas into practice could entail re-visiting a sample of event review teams' reports that identify error-forcing conditions and include corrective action recommendations for station or plant processes and programs. An in-house self-analysis would ask how these, including their root cause analyses, relate to structuring choices.

This step would become the center of self-assessment initiatives across varied groups at utility and station levels. To assure system-wide perspectives, the groups would be made up of those with the same job responsibility in different functions, people with different and similar lengths of service, representatives of varied professional and craft specialties, and some established cross-level committees, such as safety review committees.

Their discussions, I predict, would arrive quickly at the eternal triangle: the protect-perturb-produce tradeoff triangle to be found in one version or another in all high consequence enterprises. That is, what are called "safety," "efficiency," and "productivity" are each in practice the outcomes of tradeoffs, given the three simultaneous goals:

Protect: Design and maintain defense in depth and redundancies;

Perturb: Test backups to assure they work, disable them, change the configuration, and amplify risk;

Produce: Maintain the production schedule and maximize risk-reduction.

We know little systematically about the particular criteria managers apply in coming to their judgements among these often contradictory goals. Each self-assessment group might ask of particular events, Why did management at plant, station, and utility make the tradeoffs in the ways that they did? What structuring choices are implicated in their rationales?

Included in this exercise should be successes at preventing and recovering from events and in implementing foresighted corrective actions. Understanding choices and rationales with desirable outcomes is as important to self-assessment as what falls short.

Rationale

The distinction between formal and substantive logics is intended to help redress a persisting imbalance in the weight they carry in risk reduction. And an imbalance in respect. Formal logics now get the lion's share of importance and respect, even as they alone will continue to be inadequate for future risk-handling and productivity. The logics' partnership is essential.

Mobilizing these ideas requires investing in thinking and reflecting time – a lot to ask in enterprises that are, as one insider put it, “tactically oriented, not analytically oriented.” But those responsible for plant operations, including those not on site, are thinking strategically and substantively in any case, as they consider the consequences of utility and station policy changes, changes in ownership, investments in plant upgrades and up-rates, recruitment plans, operational improvement programs.

In substantive logics as in formal logics, one rationale entails another and another. That systematicity can prevent lasting improvements from corrective actions or prevent their initial implementation. Understanding decision rationales underlying structuring choices can help to anticipate corrective actions’ consequences. As another kind of self-assessment, this exercise also requires adequate resources, intellectual and financial. This approach would address systematically the NRC’s concern with cross-cutting issues: the quality of “human performance” and the enhancement of a “safety conscious work environment.”

An ambitious approach? Yes, but no less ambitious than the aspirations of executives in every high consequence industry to maintain future productivity and public trust. Satisfying shareholders can only be half the corporate mission in high consequence industries. Satisfying stakeholders is the twin mission. First among stakeholders are those responsible for daily operations, on whom all others depend.