

Management cited in bleak SQA survey

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The state of the practice in SQA is "abysmal," according to Don Reifer, a consultant who surveyed 108 firms for the American Society of Quality Control and five other organizations. "We have a lot of work to do to establish a modern and responsive quality program in all of our firms," Reifer said.

The survey, conducted in late summer and early fall and released in late March, showed that most firms do not use modern tools and practices in their SQA efforts and make no effort to quantify their successes or track their costs. Most SQA employees have no formal training in statistical quality control or in related fields, the survey showed.

"They're well-trained to *assure* quality but not to *insure* it," Reifer said. "They look over the shoulder" after product development, he said, but "their role should be teaching how to engineer quality in the product."

When devising the survey, Reifer said, "I expected the state of the practice to be much closer to the state of the art, especially with all the emphasis expressed [by management] on quality. The technology exists, but the commitment doesn't. I thought they [the transfer of SQA techniques] were moving ahead. It seems that they're static," he said.

Reifer chairs the society's Software Quality-Control Technical Committee, which conducted the survey. He is also a consultant to the European Strategic Program for Research in Information Technology and an expert on Japanese software development.

Major roadblocks. The survey revealed six major issues that affect the quality of SQA organizations:

1. "Many felt that their executives only paid lip service to quality and did not fully understand how the lack of it affected a firm's ability to compete," the survey report said. "Many stated that dis-

putes were always settled in favor of productivity over quality because meeting [deadlines] was the most important thing to upper management," it said.

2. Many felt that middle managers would not free up enough resources (time, people, and equipment) "to even try to do it [software development] right the first time," the report said. That is a problem across all industries, Reifer said. "To get middle management to move, you have to put a squeeze play on them

Companies are not practicing the state of the practice. Respondents said management does not back them, but few SQA groups have the data to help managers do so.

from upper management, [staff] levels, and outside," he said.

3. Customers had no concept of quality beyond a product that worked. The respondents thought customers had to be educated about the issues in developing quality software.

4. "Many felt that the quality problems could be traced to cultural instead of management issues. The short-term and conservative nature of most firms was cited as an obstacle to quality reform," the report said.

5. Training SQA people are hard to find.

6. Training SQA people well is hard to do.

"We need to get upper management to get behind [SQA]," Reifer said. The problem is that management needs to be shown that SQA can not only improve quality, but increase marketability and —

most importantly to management — reduce the time from development to market, he said. "It can help improve schedules ... by setting in quality through guidelines and having hard [development] targets to shoot at," Reifer said.

Unfortunately, SQA organizations "can't prove they need the resources. They haven't justified their work," Reifer said. "Few firms had gathered any hard data to determine the cost/benefits of their quality programs. Most quality organizations were not required to capture cost/benefit data to justify their expenditures," the report said.

When asked what would help them do their jobs better, those responding to the survey asked for management commitment to quality, that practical metrics become available, and that CASE tools help automate quality engineering and quality assurance.

Ironically, "metrics have come of age. There are powerful tools, at least in certain areas of the life cycle, such as complexity [management] and error management," Reifer said.

Survey findings. Among the survey's findings were that:

- Most firms (74 percent) have created independent SQA organizations: 80 percent of aerospace firms and 71 percent of other firms. The fact that 20 percent of the aerospace firms did not have such organizations surprised Reifer because most government contracts require this. Equally surprising was that so many non-aerospace firms had independent SQA organizations, since there are no industry standards for them.

- As primary goals, aerospace companies sought to verify contract requirements for product compliance (41 percent) and quality assurance (21 percent), while nonaerospace firms' primary goals were quality assurance (30 percent) via testing and validation and defect removal

(17 percent). However, in response to a question on roles and responsibilities, nonaerospace companies said compliance auditing was a more important SQA role than testing — contrary to their stated goals (where compliance auditing ranked at 10 percent).

Achieving excellent quality and teaching quality ranked 5 and 4 percent, respectively, overall. More aerospace firms (8 and 5 percent) thought them to be major goals than other firms (3 percent each).

Validation and verification are usually handled by third parties in government aerospace contracts, so it is not surprising that this was not a primary goal for aerospace firms, Reifer said. This independent verification gives aerospace-developed software technical quality assurance in addition to the compliance testing undertaken by the aerospace firms, he said. Other firms must handle both types of assurance themselves, he said, making it harder for them to achieve high quality.

- Many firms tailor their SQA programs to the needs of individual projects through goal-setting exercises. Many firms (30 percent) also make their SQA organizations handle both quality assurance and configuration management. Very few (3 percent) have their organizations handle reliability engineering and safety analysis.

- The typical SQA staff member had six years of experience in software development, had more than two years of quality-assurance experience, and could program in at least two languages.

- But despite their average of more than two years of SQA experience, most had not been formally trained in the quality aspects of their jobs. They lacked knowledge of probability theory and had not been educated in statistical quality control or measurement concepts. Few SQA organizations train their staff in project or configuration management. Less than 25 percent had professional certifications in SQA from professional organizations.

- Most firms implemented their quality programs through audits, reviews, testing, and walkthroughs. But most did not use most modern statistical approaches to quality control, such as those popularized by W. Edwards Deming. Most also did not use Japanese-style consensus methods, such as quality circles.

- Aerospace firms relied more on audits (92 percent) and reviews (77 percent) than other methods. They also did extensive traceability analysis (67 percent) because their contracts required it. Nonaerospace firms relied more on testing (86 percent), audits (58 percent), and reviews (54 percent). Walkthroughs

and inspections were listed as essential to almost all firms. Pareto analysis (looking for the 20 percent of the system that causes 80 percent of the problems) was used by only 10 percent of the firms; error-prone analysis was used by only 6 percent.

- Very few firms — 12 percent — used hard indicators to quantify quality. These indicators were error rate, error density, and error severity. Six percent of the firms used some variation of software size, such as lines of code, to measure these quality indicators against. Less than 4 percent used metrics to measure the complexity, maintainability, or testability of their software, despite the requirements of several Defense Dept. standards.

- Very few firms used commercial SQA tools. No mechanical tool exceeded 14

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percent (program comparators); interface analyzers were the least used (1 percent). Manual tools were used the most by far: 79 percent used checklists, 69 percent used standards, 44 percent used brainstorming sessions, and 24 percent used error lists.

- Only 4 percent used reliability models, while only 7 percent used complexity models. For reliability, firms used the Lipow (50 percent), Littlewood (25 percent), and Shooman (25 percent) models — the Schick-Wolverton, Jelinski-Moranda, and Musa models widely cited in the technical literature were not popular. For complexity, 75 percent used the McCabe cyclomatic number; the rest used the Halstead models.

- Only 13 percent of firms formally quantified the cost of their SQA programs. This was true for aerospace firms, even though many Defense Dept. contracts mandate it. Few firms had gathered any hard data to determine the costs and benefits of their SQA programs; most SQA organizations were not required to provide this information to justify their expenditures. The popular measure of success in aerospace firms

was the number of problem reports solved and audit reports issued; in non-aerospace firms, it was the decrease in customer complaints.

- SQA typically took 7 percent of the software budget, although this varied considerably. Organizations that assign SQA personnel to testing typically spend more money (for more staff), while those that do little more than audit spend less. Of the firms' professional staff, 40 percent worked on software, an unsurprising figure because many of the firms are software houses or banks. But the percentage of software personnel in aerospace firms was higher than expected: 28 percent of all engineers.

- All but 13 percent of SQA personnel had at least a bachelors degree; the rest had associate degrees. Nonaerospace firms were twice as likely to hire staff with AA degrees as aerospace firms. Fifteen percent had masters degrees; telecommunications companies were the most likely to assign staff with masters degrees to SQA jobs.

- About 30 percent of the firms use technicians to do mundane work that would otherwise be done by the SQA staff. The firms that do so usually assign one technician for every four SQA professionals. Firms that emphasized configuration management were most likely to use technicians, so the study "inferred that technicians handled configuration-management tasks like library control."

- About 20 percent of the firms rotated staff into SQA organizations; most of those rotated into SQA came from software-development departments. The average tour of SQA duty was one and a half years. Several firms required a tour of SQA duty as a prerequisite for promotion, encouraging highly qualified employees to work on SQA.

- Professional certification in SQA seemed more important to nonaerospace firms (27 percent) than to aerospace firms (10 percent).

The questionnaire was mailed to 1,636 firms; of the 108 respondents, there were 39 aerospace, 15 banking, three educational, six energy, two entertainment, four food and beverage, six health care and pharmaceutical, four insurance, four retail, and nine software firms. Two respondents were government agencies.

Participating organizations in the survey were the Aerospace Industries Association, Electronics Industries Association, National-Security Industrial Association, Society for Information-Systems Quality, and Southern California Quality-Assurance Association. Copies of the report are available from the Minneapolis-based American Society of Quality Assurance.