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Teaching Big Brother to be a team player: Computer monitoring and quality

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Executive Overview

Computer monitoring should not be seen as a way of gathering information about workers, per se, but rather as one part of a production and quality strategy that provides needed information to a diverse team of workers. In its most powerful and effective form, computer monitoring is the use of computers to collect, process, and provide feedback information about work with the intent of improving performance and developing employees. Unfortunately, computer monitoring has also been used to punish employees. Here, a study of a successful computer monitoring system at Hughes Aircraft Company is described. The study shows that computer monitoring can facilitate integrated production and quality control strategies without negative effects on employee quality of work life. Managers who wish to design and effectively use computer monitoring systems should: (1) Use the monitoring system to provide feedback data to the workforce—not to gather social information (e.g., time taken for bathroom breaks); (2) Determine the type of data that employees believe will help them and be willing to adapt the system as they get ideas about how to use the data; (3) Design a system that gathers integrated data—data that will allow for useful comparisons between, as well as within, specific tasks; and (4) Realize that computer monitoring is only as noxious as the management system itself.

Computer monitoring has a bad name. Consider the titles of some recent articles in the business press: "Big Brother is Counting Your Keystrokes," "How Companies Spy on Employees," "Employee Performance Monitoring . . . or Meddling?", "The Dark Side of Computing," "The Boss that Never Blinks."[1] These titles capture the primary way in which computer monitoring has been used in the workplace—as a surveillance technique to control employee behavior. Eavesdropping is not acceptable behavior outside the workplace so it's not hard to understand why electronic eavesdropping within it elicits negative reactions.[2]

The privacy issues inherent in computer monitoring have attracted the attention of the courts and Congress. For example, Mayor Robert Isaac of Colorado Springs, Colorado has been sued for reading the electronic mail messages that City Council members sent to each other from their homes during 1990. Isaac defended his actions by saying he was making sure that electronic mail was not being used to circumvent the Colorado "open meeting" law that requires most council business be conducted publicly.[3] Similarly, Epson America Inc. was named in a class action law suit concerning a systems administrator who eavesdropped on electronic correspondence.[4] These are not isolated instances and the problem is likely to grow worse. Sales of computer monitoring software hit $176 million in 1991 and are projected to grow fifty-percent annually through 1996.[5]

Many European countries have enacted anti-monitoring laws and, during 1991, H.R. 1281 and S.516—the "Privacy for Consumers and Workers Act"—were introduced in the U.S. Congress. Key components of these bills would require employers to provide prior written notice of:

- The forms of electronic monitoring to be used
- The types of personal data to be collected
- The frequency for each form of electronic monitoring which will occur
- The use to be made of personal data
- Interpretation techniques for collected information
- Existing production standards and work performance expectations
- Methods used for determining production standards and work performance expectations based on electronic monitoring statistics

The proposed legislation also would require that random or periodic monitoring be accompanied by a signal when the monitoring occurs, such as a signal light, beeping tone, or verbal notification.

Testimony at Congressional hearings also suggests that computer monitoring may detrimentally affect employee health. For example, a study by the University of Wisconsin and the Communication Workers of America found that computer monitoring was related to reports of physical complaints such as stiff or sore wrists, back pain, and headaches,[6] which also are associated with the fastest growing category of workers' compensation claims—repetitive stress injuries.

With this history, it is not difficult to understand why computer monitoring has a bad name. But does computer monitoring have to invade privacy or harm employee health? The answer is clearly, "No." In its most powerful and effective form, computer monitoring is the use of computers to collect, process, and provide feedback information about work with the intent of improving performance and developing, not punishing, employees. Work by Judith Komaki supports the idea that the most effective managers are involved in observing and improving the work process.[7] At AT&T, for example, computer monitoring technology is being used as part of a pilot project using self-managed teams to operate telephone call centers. The monitoring system allows experienced operators to listen in on less experienced operators' calls and coach them. Used in this manner, computer monitoring might be considered an electronic adjunct to Tom Peter's "management-by-walking-around," where managers gather information by observing employees working and then providing help when needed.

Computer monitoring can be an effective management tool in work settings when used as part of an entire production strategy—as part of a feedback system or by providing process information about how work actually gets done.[8] The competitive advantage of a computer monitoring system is that it can collect complex, interrelated data quickly, unobtrusively, and won't (usually) forget. The *most* effective strategy is when computer monitoring is an integral part of a production system and the focus is on improving the work process, rather than on controlling employee behavior.

The Case of CVITS

Setting: High technology clean room production facility. Workers dressed in sterile white "bunny suits" and booties. Powerful microscopes connected to computers and video screens. Wires running to straps on the workers' wrists.

This could be the opening scene from a science fiction movie where a computerized boss shocks workers' wrists whenever they are sensed to be slacking-off or making mistakes. The story is only partially fiction. These are microchip inspectors; the wrist straps are grounding wires so static electricity will not damage the delicate product—not torture devices. However, management *is* computer assisted.

Hughes Aircraft Company's Computerized Video Integrated Technology System (CVITS) provides an example of computer monitoring being used as an integral part of a production strategy, highlighting its "value added" potential. The system is used in their microchip production and inspection processes. The microchips produced in this system retail to the Department of Defense for more than $10,000. One inspector may see hundreds of parts per day. Much of what has been written about computer monitoring focuses on the importance of quantity versus quality.[9] Here, we show a system where the focus is clearly on quality and the use of a new tool by both managers and subordinates who are well versed in relating quality data back to the work process.

Thus, this example of computer monitoring is different from others[10] in that it is manufacturing oriented and provides data at a level where managerial issues can be closely examined. An Office of Technology Assessment report[11] summarizing the results of many computer monitoring attempts suggests that computer monitoring has negative effects. The limited results from more recent controlled studies, on the other hand, have not indicated negative effects on either worker performance or attitudes toward work.[12] Observing computer monitoring in a production setting where statistical process control and other empirical devices are better understood should help sort out these contradictions by illustrating the role of feedback and control as an integral part of work. This case describes a system that is both used and evaluated by the same work group that is in charge of identifying production process problems through data trends. Their familiarity with relating trend data back to the actual process should enable them to make long term effective use of the monitoring information.

Purpose and Design of the System

Strategic quality objectives drove the design of the CVITS at Hughes Aircraft Company. Hughes designed the system to collect information for the documentation of quality—increasing the convenience of the quality review process, creating a database of quality information, and developing a training and certification program using the information gathered about production. Digitized images from the inspection station microscopes are the basic technology for this system. A computer network connects these inspection stations to "WORM" (write once, read many) optical disks and video display monitors both at the inspection stations and upstairs in the supervisor's office. The system also allows for keyboard entry of text data onto the WORM disks.

The system provides two types of monitoring. One is the "real-time" video connection to the microscope stations used to inspect the microchips, which is also available remotely in the supervisor's office. The system achieves this real-time monitoring through simple video cables and a switch box that allows the supervisor to switch from one station to another. The other form of monitoring is archival. The inspectors take the digitized image of each defect and store the image and a text description (disposition) of the defect on the WORM disk. The supervisory and engineering staff then refer to this computer file to verify the disposition of each defect. If they change the verdict of the inspector, or if there are any other comments about the inspected part, this information is stored in the file. These data can be analyzed to identify consistent discrepancies between inspector/supervisor/engineering decisions or production trends.

Another feature of the CVITS is that its design was the impetus for the engineering staff to create an on-line library of "classic" examples for each defect an inspector might find. This library is available at each CVITS station and allows team members to compare questionable defects with the library definition. The library is indexed both by type of defect and by Department of Defense contract definition.

Quality within the manufacturing process is a collaborative effort where the final product is the joint responsibility of the entire production team. The Hughes team, consisting of the entire staff of inspectors, quality engineers, and production engineers, collectively identifies production problem areas and possible solutions. The CVITS supports their cooperative work by making information available to all members of the staff. The contribution of the system to quality is that all team members can use the information to solve production process problems. Additionally, the team is discussing the possible use of the accumulated database of digitized defects to teach a neural network how to further enhance the inspection process.

CVITS' Impact on Team Members

Discussions with team members[13] revealed that CVITS was implemented by what has been called "parachuting." Senior quality control staff built the system and actual users were not consulted or really informed before its appearance at their work stations. CVITS simply appeared (parachuted) into the inspection area without any prior introduction. Apparently CVITS is sufficiently user friendly and similar to the old method of inspection that this form of introduction was possible. However, as we show later, this form of introduction does have its drawbacks. Informal hands-on training was provided after CVITS' introduction and lasted for about five minutes per person. Users were asked in the interviews if they felt they needed any formal training. Only two felt they needed further information. Apparently they found no surprises about the system's capabilities, possibly because they had no idea about what to expect.

Questions in the interview were used to determine the degree to which team members perceived CVITS to be helpful, how satisfied they were with it, and how committed they were to using the system. The results provide some insight into this particular system and its effectiveness within this work group. As Exhibit 1 shows, there is considerable variation in team members' reactions to CVITS. Inspectors and quality engineers saw the system as being more helpful and were more satisfied with and committed to its use than production engineers, whose reported reactions were neutral. Differences in these reactions are likely a result of differences in the way CVITS affects the tasks they perform. For example, inspectors find CVITS helpful in performing their jobs. Certainly the large digitized

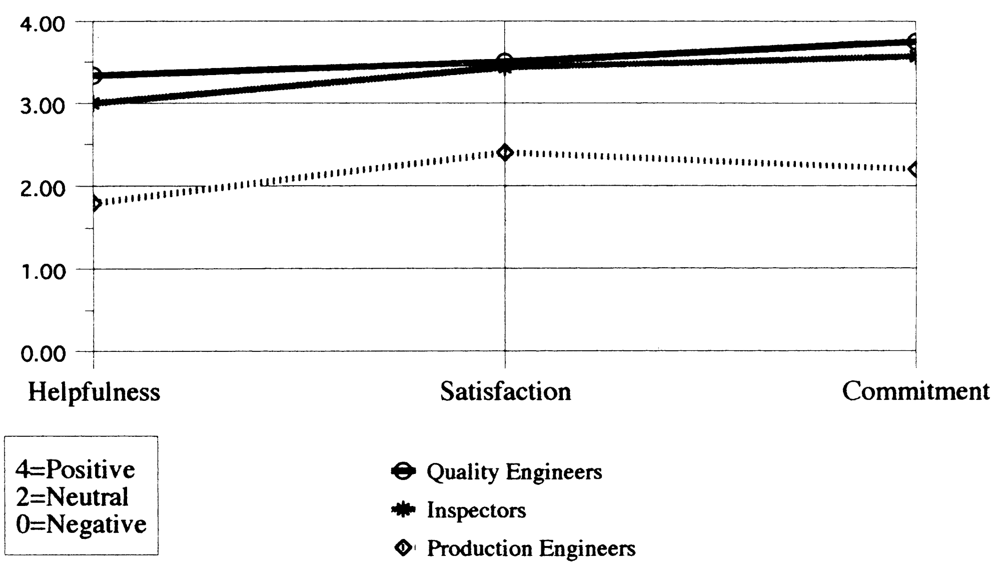

Exhibit 1. Reaction to CVITS by Team Member Role.

display of the microscopic image has advantages over looking through a microscope eyepiece and, on average, each inspector used the system about three hours per day. The biggest complaint heard from the inspectors was that there were not enough stations to go around. Some inspectors have 100-percent access to a CVITS station while others must share them. Another strength of CVITS, from the inspectors' perspective, is its archival database and ease of record keeping. However, these benefits have yet to be fully realized as the inspectors still have to maintain paper reports as well.

Quality engineers rated CVITS as helpful and, on average, used the system about 3.5 hours per day. They identify problems in production and the CVITS archival database increases the amount of information they have to work with. In contrast, production engineers, who have to work backwards to find solutions to those problems, are neutral in their perceptions of the system's helpfulness. As currently configured, the system does not provide much information that can be used to solve identified problems. This weakness may explain the production engineers' relatively low usage of the system—less than half an hour a day. However, they may increase their use of the system and become more positive about its helpfulness as the database evolves and provides information closer to their needs.

The satisfaction and commitment results parallel those for helpfulness. Quality engineers and inspectors are most satisfied with and committed to the system; production engineers are neutral. In short, it appears that team members' satisfaction with and commitment to the system are related to the extent to which they find the system helpful in performing their jobs.

The participants also were asked specific questions about computer monitoring. CVITS is configured such that the inspection supervisor and the engineers can directly monitor the inspectors through the video connection. All users have access to the archival information as it is entered by the inspectors. Five of the six inspectors volunteered that CVITS was used to monitor their work. Four of the inspectors also noted that they used CVITS to monitor other people's work (indeed, the data that they enter is a database about preceding production processes). In response to an item that asked, "How do you feel about the work being monitored," the five inspectors offered the following comments:

"No problem."
"Good for answering questions when you get stuck."
"Doesn't bother me. They're going to see it anyway. They need to see it to disposition." (Dispositioning is the final "go/no go" test before passing a part.)
"I think it's great. A way you find out where you're at."
"I don't mind. At first I was nervous, or if I'm talking and you leave the [part just sitting there]—she can see if it's sitting there . . . if she has it on in her office."

These comments acknowledge that the CVITS does allow for surveillance. However, they also indicate (as do the satisfaction results presented in Exhibit 1) that CVITS is not creating an "electronic sweatshop" or Orwellian work environment. CVITS is acknowledged to have feedback as well as supervisory functions.

The Problem with "Parachuting"

CVITS is a technical success that paid for itself by simplifying the identification of defects. On another level, however, the system has not been as successful. As the study shows, people in different roles have different understandings about CVITS, which is probably true in most computer monitoring situations. Inspectors see it as pieces of equipment (monitors, keyboards, etc.). Engineers focus on either its dispositioning aspect or its statistical process control capabilities, depending on their particular role. However, team members do not uniformly see CVITS as part of an overall quality control strategy. This is perhaps the only problem caused in this setting by "parachuting" the system in, and it appears to be the biggest barrier to attaining the system's full potential.

An understanding of CVITS' role in the quality/production strategy is necessary for its full utilization. Team members need to understand the whole production process and how CVITS fits into this process to make full use of the system.

The parachute method of implementing CVITS allowed each of the different work groups to develop their own, bounded understanding of the tool—each group focusing only on how CVITS would affect their *jobs. Training and participation in design and adaptation may be the key to developing shared sets of meaning between the different roles. A joint implementation effort, where inspectors, supervisors, and engineers all would be exposed to the system at the same time and in the same context, would have been more likely to support a common understanding of the system.*

Such an implementation strategy would also help the three groups find synergies within and across their roles, as well as within the CVITS data. For example, production and supervision may have knowledge that would help inspectors better understand and predict problem areas, or, inspectors may have production hypotheses about patterns of problems that they identify in the microchips. Bringing supervision, production, and quality control closer together should create benefits throughout the production process.

CVITS was successful because it gathered quality information and feedback data for improving the workers' skills. The focus was on identifying areas to improve, not on finding reasons to punish employees.

A crucial point to make, both for the future use of CVITS at this site and within the general study of computer monitoring, is that the entire production strategy should be considered when planning for the system and its use. Monitoring of this type may include the capabilities of video monitoring, computer monitoring, and statistical process control. The role of the monitoring system, for example, is to allow inspectors, supervisors, and engineers to access and use detailed information about the production process. Successful monitoring is not just a surveillance tool for management. Instead, monitoring can be a part of a production strategy used by the entire work group.

It is likely that previous negative reports about computer monitoring describe issues that are not solely due to the technical design of the system. Both the Office of Technology Assessment report (which is full of warnings about computer monitoring) and this Hughes Aircraft/CVITS case examine computer monitoring without controlling for organizational or managerial factors. However, the lack of negative results here (e.g., inspector dissatisfaction or lack of commitment) is probably not due to the mildness of the CVITS technology. Rather, CVITS provides a full spectrum of monitoring capabilities and the CVITS users seem to be making justifiable choices about which data to collect and how to use it.

The implication is that computer monitoring is only as evil as the management system that employs it. The management system at Hughes Aircraft is apparently not a noxious one. The users were generally satisfied with it.

Teach Big Brother to be Part of the Team

Computer monitoring does not have to abuse workers by creating an electronic sweatshop environment. It is just another managerial tool that needs to be used responsibly. The following are some guidelines[14] for the effective use of computer monitoring, both from the perspective of employee privacy and the acquisition of useful production data.

(1) Use the monitoring system to provide feedback data to the workforce—not to gather social information (e.g., time taken for bathroom breaks). CVITS was successful because it gathered quality information and feedback data for improving the workers' skills. The focus was on identifying areas to improve, not on finding reasons to punish employees. Data that is available to all members of the team is more likely to promote improved production processes. The CVITS inspectors participate in the collection of the data and understand that the data *must* be gathered to meet contract requirements. Engineers, as well as supervisors and inspectors have equal access to the files and can look

for areas to improve. The idea is for the team to constantly consider new methods and techniques—as well as providing additional training to improve inspectors' skills. Moving away from systems where only supervision can access the data is certainly one way to improve both employee understanding of the system and encourage use of the data within the production team.

(2) Determine the type of data that employees believe will help them and be willing to adapt the system as they get ideas about how to use the data. Most computer systems must be adapted to suit particular situational requirements. A critical feature of both computer-aided-manufacturing in general, and computer monitoring, in particular, is that the systems can be adapted as particular information needs are identified. CVITS' initial form was simply a computerization of tasks previously handled manually. As workers become more aware of other useful data, the system can be adapted to collect it. The CVITS users are aware of the flexibility of the system and have already requested that the tracking paperwork also be computerized. Training on and about computer monitoring systems should emphasize the adaptability of the system and encourage workers to provide suggestions about important and useful data.

(3) Design a system that gathers integrated data—data that will allow for useful comparisons between, as well as within, specific tasks. This should help increase the value of the system to employees, increasing their commitment to its use. CVITS combined video images of chip defects with a text database including the fault disposition provided by the inspectors. As CVITS is implemented in earlier production stages (i.e., production itself, rather than just inspection), production process variables can be linked to particular flaws. Integration between production and inspection can promote quicker solutions to production problems.

As these changes occur, we expect that production engineers will perceive CVITS as more helpful and become more committed to its use. Integration between tasks is likely to increase employee perceptions that computer monitoring is a tool, not a punishment device. Providing integrated data will show that a specific group or individuals are not being singled out for monitoring. Integrated systems, such as CVITS, allow for complex relationships among tasks to be better understood and optimized.

(4) Most important, realize that computer monitoring is only as noxious as the management system itself. Similar to time-motion techniques, computer monitoring provides managers with information that they can use for either good or ill purposes. Time-motion studies identified areas for more efficient production. They also provided information that could be used to decrease the rate paid for piece-rate compensation. Not surprisingly, workers focused on the later use and found ways to manipulate the data. Computer monitoring can identify areas for more efficient production, training needs, and production process improvements. However, if workers believe that management will use monitoring against them they may use their creative skills to find high-tech wrenches to throw into the "works." A Wang word processing representative acknowledged, for example, that ways around keyboard counts are as old as keyboard monitoring systems (e.g., computer programs that automatically enter huge blocks of text). A better outcome would be that they applied these skills to finding better production methods.

The common theme in these four suggestions is that modern quality control calls for the empowerment of the workforce for the improvement of the production process. The suggestions above build off ideas of employee understanding of the monitoring system and employee use of the data. Computer monitoring is developing at the same time as our management process is relying more and more on management roles being taken over by nonsupervisory employees or teams. The key may be to turn over computer monitoring to the workforce. With the data diffused throughout the production process, employees will better understand it, fear it less, and be more likely to find significant production process improvements. Workers are already learning statistical process control for their production areas. Why not let them use it to include themselves in the monitored processes? Better yet, create an incentive structure that rewards employee-driven improvements, then allow the employees the choice of tools to help them reach their goals. We don't have to lose Big Brother's skills, if he can learn to be a team player.

Endnotes

This research would not have been possible without the conceptual and practical assistance of Hughes Aircraft Company's Edson B. Gould, William Joyner, Geoff Hunt, and the users of the CVITS. I would also like to thank Raymond Zammuto and Gregory Northcraft for their invaluable comments and editorial assistance.

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[3] J. Markoff, *New York Times,* May 4, 1990.

[4] C. Casatelli, "Electronic Mail: Setting Ground Rules for Privacy," *Computerworld,* March 25, 1991, 47, 50.

[5] Ibid., *Fortune,* 140.

[6] M.J. Smith, P. Sainfort, K. Rogers, & D. Legrande, "Electronic Performance Monitoring and Job Stress in Telecommunications," University of Wisconsin—Madison, Department of Industrial Engineering, October 1990.

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[11] U.S. Congress, "The Electronic Supervisor: New Technology, New Tensions," Washington, D.C.: U.S. Government Printing Office, 1987.

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[13] Several site visits to the CVITS site were made to gather information for the description of the system and to develop the structured interview for assessing the method of implementation and its success. The resulting interview included questions regarding the processes of implementation (socialization/training, rewards/helpfulness of systems, commitment to system) and multiple measures of implementation success (knowledge of system, use of system, attitudes about system). The focus was on perceived and actual outcomes relevant to the system. Each interview was conducted in a private office during work hours and took approximately forty minutes. Several hours were also spent simply watching the team use the system. The system's two designers also were interviewed. Their responses have not been included in the sample except as a measure of the technical capabilities of the system. This decision was made based on the designers' responses being singularly positive and showing no variance. For further information, please contact the author.

[14] A complementary set of guidelines appear in Grant, et al. (1988).

About the Author

Terri L. Griffith (Ph.D., Carnegie Mellon University, organizational psychology and theory) is an assistant professor of management and policy at the University of Arizona. Her primary research interests are in the application of social psychological theories to the implementation and effective use of new technology. Her current research focuses on cognitive issues in the implementation of new technology (both in the U.S. and abroad), the effective and appropriate use of computer monitoring and feedback, and the role of facilitators in group decision support systems.