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Reprint

THE HUMAN FACTORS APPROACH TO REDUCING PRODUCTION ERRORS

Alan D. Swain

RELEASED FOR ANNOUNCEMENT
IN NUCLEAR SCIENCE ABSTRACTS

SANDIA CORPORATION

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THE HUMAN FACTORS APPROACH TO REDUCING PRODUCTION ERRORS

Introduction

Production workers' errors pose a big problem to management. Such errors are costly both to management and to workers. They reduce profits and they result in smaller and less frequent raises. But, all too often, the attitude of management and supervisors not only fosters errors but also hinders the development of an analytic approach to reducing them.

Human factors engineering is one approach to reducing errors. By using human factors techniques, it is possible to match equipment, tools, and procedures to the capabilities and limitations of those who must use them.

Let's take a look at some existing attitudes of managers and supervisors toward worker errors. First off, the very word "error" suggests something that is wrong. Synonyms for errors are "mistake," "blunder," "slip," and "lapse." The word err means to fall into error, to go astray, especially to do wrong or to sin. Thus, error has a connotation of blame, of someone's being responsible for whatever has gone wrong. But do workers really make errors because they want to?

Whose Fault?

Some managers and supervisors would answer the question with an emphatic YES. Others--no doubt the majority--would state more reasonably that such descriptions fit only a very few of their subordinates. And

yet, by their reactions to errors, even many of these supervisors would appear to feel that errors are the sole fault of the worker who makes them.

We often hear, too, such comments as, "If people would just follow instructions, the job would be done right," or, "If people would just do what they are supposed to do, there wouldn't be so many rejects," or, "If people were just more careful, there wouldn't be so many accidents."

These statements imply personal blame. Are they objective and rational assessments? Do they state the problem in terms that really will help to reduce worker errors?

Consistent Inspection Errors

To answer these questions, let's look at the inspector's job in a production plant. We use the inspector's job only for convenience; any number of jobs could be used to make the same points.

Average inspection error rates of 15% occur with surprising regularity even where motivation to avoid errors is intense. For example, inspectors in some plants which make parts for military weapons exhibit an average 15% error in detecting defects. These inspectors know the possible serious consequences of allowing defective parts to go into our military arsenal. They have had pressure put on them by management--and yet the 15% average error rate still holds. Psychologists who have interviewed these inspectors do not feel that they are indifferent to inspection errors.

And the 15% error rate is by no means unique to military weapons plant inspectors. Studies have shown that a 15% average error rate is typical of inspection tasks performed on many different kinds of equipment and under a great variety of work conditions. A recent study in

Great Britain on inspector accuracy produced the same average error rate--15%.

Is it reasonable to assign this constancy of behavior to worker indifference, laziness or some other undesirable trait? Or is it more reasonable to suspect that something about these inspection tasks may be causing the 15% error rate? The problem is really not hard to identify.

It turns out that the 15% inspection error rate is more or less characteristic for many types of inspection tasks where the defect rate is low--that is, where the ratio of defects to acceptable units produced is about 1:100 or less. Since inspection demands vigilance, it is not surprising that vigilance decreases when the error being inspected for does not appear very often.

Many studies have shown that when dealing with a rare event, we soon develop an expectancy that the event will not occur this time. Often this expectancy develops without the inspector's being aware of it. The resultant decrease in vigilance can occur even when someone's life could be at stake.

Analytic studies of shipboard lookouts during World War II demonstrated that vigilance could be maintained at a high level only for about a half-hour. After that, despite no let-down in motivation, there was a sharp decrease in the probability of a man's seeing a submarine or other enemy vessel or aircraft.

With this insight into the problem of vigilance, it may be possible to reduce inspection errors. When inspectors at one manufacturing plant also making critical parts for military weapons were missing more than 15% of the defects, despite management appeals and despite the inspectors' best intentions, the first question an industrial psychologist asked suggested a solution. How long did inspectors inspect at any one sitting? Inspectors spent a whole day at a time inspecting, because parts were saved up until there were enough to keep them busy that long.

The solution, in view of the vigilance studies, was simple. The inspectors should inspect no more than one-half hour at a time. Then they should do something else--anything but an inspection task--for at least one-half hour, preferably longer. Then they should do another half-hour's inspection, and so on. This one change was enough materially to reduce the number of defects getting by the inspectors.

The primary point is that it is usually much better to try changing the work situation rather than the worker. Thinking about changing people often means attacking symptoms, not causes. Attempts to get workers to employ better "workmanship" often backfire and can actually result in worker resentment of management and supervision.

After all, if a worker is already doing as well as he can under present work conditions, he is not likely to take kindly to the implication that "if only he would do better, all would be well." When the worker already has at least average motivation to do well, as most workers do, then the use of emotionally toned words to describe worker errors may well make the situation worse.

Analytical Approach

In the analytic approach to worker errors the first step is to look at the work situation to see what may be fostering errors.

If management places undue emphasis on worker speed, then it should be prepared to accept a higher than usual error rate.

If a production fixture requires that a worker use three hands to load it, then management should not be surprised to see a high rate of dropped and damaged parts.

If an assembly has five wires to be threaded and soldered to five different locations and if it is physically possible to interchange these wires, management should not be surprised that errors occur, even if color coding is used.

In the last case, a more analytic approach would be to design the assembly so that the shortest wire will reach only the nearest solder point, the next shortest wire will reach only the next nearest solder point and so on. The other problems can be resolved in a similar way.

To sum up, the old, unanalytic approach of blaming workers for their errors usually does not result in a permanently lower error rate and, in fact, may increase it by arousing worker resentment. Motivational appeals for workers to "do better" often rapidly lose their effectiveness. We tune out propaganda much as we tune out annoying television commercials.

A more analytic and rational method of reducing worker errors is to look at the design of the worker's tools, fixtures and procedures to see if there are features in the job itself which foster human errors despite the worker's best intentions. This "human factors engineering" approach results in jobs designed for man as he is, not as some might wish he were.

The method has been used successfully in designing low-error military systems and equipment for military personnel's use. It can be used with equal success in designing production systems to reduce worker errors to acceptable levels.