Preventing Accidents

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For quite some time now, managers have been using education, job training and experience as indicators of proficiency. Just how good a policy is this? Everybody does it. It often seems to be the best guarantee we have that a person will do the job well.

One reason this is taken for granted is because it is so hard to measure proficiency. We have not had any practical way of measuring proficiency, but now we do (please see below).

- Proficiency is the ability to do a job well under a variety of conditions and over time.
- A *Shuford Wisdom Gym Proficiency Assurance System (SWGPAS)* is a computer-based setting where participants work exercises using a unique measuring tool to reveal their proficiency. Each exercise contains work samples to be solved. Participants can use the knowledge of results and track records provided by *SWGPAS* to guide their learning.

Here, we use it to see just what training and experience buys us in the way of job proficiency, productivity and profit.

This study focuses upon the job proficiency of operational support workers. These are the people operating the critical physical systems supporting industry. They continually monitor a variety of systems. Many of these systems are quite complex. The systems must operate within certain limits. These workers make repairs on many of the systems. A system breakdown often interrupts operations at the facility. Also, breakdowns may damage or destroy other equipment and systems. Sometimes, loss of life is a consequence of failure.

Workers for a new facility were hired according to education and job experience. All had orientation and safety training. Many then attended vendor-provided classes on the new systems. All began hands-on training on assigned systems.

Engineering staff and management created 2,078 work sample problems making up 97 exercises.

FACILITIES EXERCISES

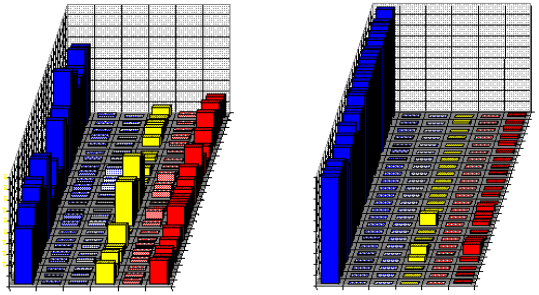
Mastery Exercise Name	Work Samples
Boilers - Part 1	25
Boilers - Part 2	25
Boilers - Part 3	24
Boilers - Part 4	25
Boilers - Part 5	14
Chemical - MSDS	22
Chillers - Part 1	23
Chillers - Part 2	23
Chillers - Part 3	21
Chillers - Part 4	25
Chillers - Part 5	21
Cleanroom - Part 1	24
Cleanroom - Part 2	23
Cleanroom - Part 3	27
Chemical - D2000	25
Chemical - D5500 Part 1	20
Chemical - D5500 Part 2	21
Chemical - Data Supervisor	30
DI Water - Part 1	19
DI Water - Part 2	24
DI Water - Part 3	17
DI Water - Part 4	28
DI Water - Part 5	25
Safety - Electrical/Lockout	19
Electrical - Part 1	25
Electrical - Part 2	24
Electrical - Part 3	20
Electrical - Part 4	20
Electrical - Part 5	25
Electrical - Part 6	24
Electrical - Part 7	23
Exhaust System - Part 1	23
Exhaust System - Part 2	25
Safety - Fire/Chemical	17
Safety - Gas	20
Gas - Part 1	19
Gas - Part 2	20
Gas - Part 3	17
Gas - Cabinets	25
Gas Cabinets - Part 2	21
Gas Cabinets - Part 3	27
Gas - Safety 1	24
Gas - Safety 2	20
Gas - Safety 3	15
Gas - MSDS	18
Gas Operator - Part 1	18
Gas Operator - Part 2	20
Gas Operator - Part 3	20
Gas Operator - Part 4	17
Gas Plant	21
Safety - HAZCOM	19
Industrial Waste Water - Part 1	25
Industrial Waste Water - Part 2	25
Industrial Waste Water - Part 3	25
Industrial Waste Water - Part 4	25
Industrial Waste Water - Part 5	25
Safety - Lasers	12
Cleanroom - MAHU - Part 1	22
Cleanroom - MAHU - Part 2	22
Chemical - MX90	15
Chemical - MX95	25
Process Cooling Water - Part 1	25
Process Cooling Water - Part 2	24
Process Cooling Water - Part 3	25
Process Cooling Water - Part 4	21
Process Cooling Water - Part 5	25
Gas Operator - Part 5	28
Gas Operator - Part 6	29
Safety - Equipment/Ergonomics	12
Sample - Four problems easy to hard	4
Safety - Radiation	20
Chemical - SCI5500 Part 1	16
Chemical - SCI5500 Part 2	16
Chemical - SCI5500 Part 3	16
Chemical - SCI5500 Part 4	18
Facilities/Safety Terms - Part 1	20
Facilities/Safety Terms - Part 2	21
Facilities/Safety Terms - Part 3	20
Facilities/Safety Terms - Part 4	21
Facilities/Safety Terms - Part 5	21
Facilities/Safety Terms - Part 6	20
Chemical/Gas Terms - Part 1	20
Chemical/Gas Terms - Part 2	19
Chemical/Gas Terms - Part 3	20
Chemical/Gas Terms - Part 4	20
Chemical/Gas Terms - Part 5	18
Chemical/Gas Terms - Part 6	20
Cleanroom - Solvent Waste System	25
Safety - Confined Spaces	16
Chemical - Systems Symbols Part 1	20
Chemical - Systems Symbols Part 2	20
DI Water - Ultrapure - Part 1	25
DI Water - Ultrapure - Part 2	25
DI Water - Ultrapure - Part 3	25

These 97 exercises in turn made up 19 job areas. Management assigned several areas to each worker. The worker built a track record showing mastery for all exercises in the assigned area. The worker then reported to training. A trainer confirmed the worker's identity and called up a qualifying Exercise. This qualifying Exercise randomly drew work samples from all of the area.

As a worker proceeds through an Exercise, *SWGPAS* reveals the correct solution after each work sample problem is solved and gives a Diagnosis.

DIAGNOSIS	PATTERN	IMPACT
Assured Dark blue	**Strongly committed to correct solution**	**Correct action taken quickly, under stress and remembered longer.**
Hesitant Blue	**More committed to correct solution than any other**	**Correct action taken more slowly, vulnerable to stress and forgetting.**
Partially Informed Light blue	**Undecided between correct solution and other(s)**	**Some time required to gain needed information before acting, otherwise mistake is likely.**
Undecided Yellow	**Not committed to any of the solutions**	**Much time required to gain needed information before acting, otherwise mistake is highly likely.**
Misinformed Pink	**More committed to an incorrect solution than to the correct one**	**Time may be taken to resolve doubts in situations perceived as critical, otherwise a mistake is sure to be made.**
Deluded Red	**Strongly committed to an incorrect solution**	**Incorrect action taken immediately without checking with supervisor, coworker or referring to manuals.**

The chart to the left below shows the distribution of diagnoses for each job area for trained and experienced workers. Even after training, being *undecided* (in yellow) was fairly common. These job sample topics were untouched by training. Having a *deluded* (deep red) was even more common. Each *deluded* (deep red) is potentially an accident waiting to happen.



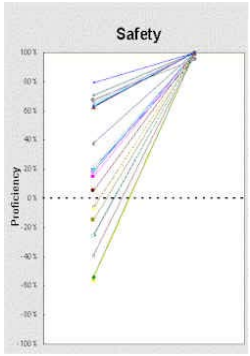
The chart to the right shows problem status as workers repeated exercises in order to improve and to maintain job proficiency. After using the *SWGPAS* as a guide to learning, deficiencies become very rare indeed. We find this whenever focus is placed on the output of training (learning and proficiency) rather than on the input (time, cost, effort, mode, etc.). Workers can now see what they need to learn. They can now see how well they are doing. Here, *deludeds* (deep red) are almost nonexistent. The absence of deficiencies means everyone is *assured* (dark blue) on nearly every work sample problem. Everyone should act quickly and correctly, even under stress, when similar problems occur. To the extent this happens, mistakes should be prevented.

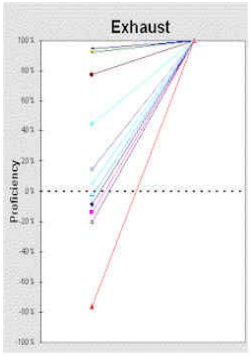
A *SWGPAS* also tracks a scaled measure of proficiency. This scale has a zero point corresponding to the *undecided* problem status. The measure ranges on up to 100% proficiency representing mastery. Unlike other performance measures, it also goes down into the -100% or more range to allow for the negative impact of *deludeds* and being *misinformed*. Ineptness can more than offset the advantage of a skill. This gives us another way of looking at the outcomes of training and experience.

Here shown to the left below is what happened in the safety area. All these workers had attended the company orientation and safety classes. All had passed written safety tests. All had left with a copy of the safety manual for refreshing their memories. Some days or weeks after completing the safety class, these workers did the *SWGPAS* safety exercises for the first time. These safety exercises covered the material presented in the class and printed in the safety manual. The results appear as the vertically arranged line of points on the left side of this graph. Each point represents the scaled measure for one worker.

Notice that the best performance was about 80%. The worst was almost down to -60%. On eight out of the 21 exercises the worker's incompetence outweighed their competence. No wonder accidents happen!

The data points on the right of the graph show worker performance on the qualifying exercise. A line connects the beginning and the end points for each worker. The worst performance qualifying on *SWGPAS* in the safety area is 96%.





The graph on the right shows the same type of data for a major operations support system. Two workers began above the 90% level. Proficiency levels of others ranged down almost to -80%. Hopefully one of the two or three most competent workers was usually on duty. They would be available in case anything happened to the exhaust system.

These workers used *SWGPAS* to guide their study of training and operations manuals. They also discussed problems with coworkers, supervisors and engineers.

This led to the performance shown to the right of the graph where everyone achieved 100%.

We found results similar to these for all of the job areas. Proficiency as initially measured ranged from near 100% down far into the negative range. Training and job experience are no guarantee that a worker can do the job well.

Giving workers access to a *SWGPAS* at the job site and assigning them the task of qualifying in designated areas did indeed result in high levels of proficiency. Clearly, the job proficiency of these workers improved markedly over a period of months. What economic impact did this have upon the company?

- First, the cost of this effort was covered very shortly by reductions in insurance premiums.
- Second, the cumulative incident rate was less than half that at comparable facilities and operations.

An incident is anything that disrupts the operations of the facility. The loss from a minor incident might range in the thousands of dollars. That of a typical incident would be in the hundreds of thousands. More serious ones would be in the millions. Catastrophes causing the loss of many lives could range into the billions. In such a setting, it would not take many avoided incidents to provide a great return on investment. For example, avoiding each year a dozen typical incidents or a couple of serious ones would make an important addition to the bottom line.

Looked at another way, suppose incidents typically cost a facility a grand total of $10,000,000 a year. Reducing the incident rate by 50% or one-half gives an expected savings of $5,000,000. Similar reasoning leads to the conjecture that currently used training methods and experience requirements fail to prevent many mistakes in many jobs and industries. Remedying these deficiencies in proficiency across these industries could well produce astronomical savings.