

# Increasing Productivity

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and

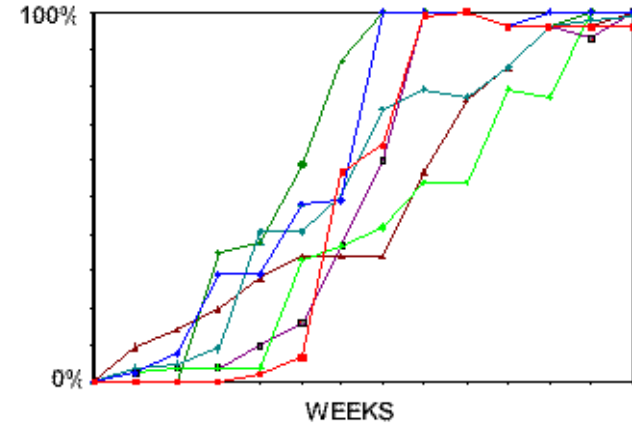
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# MANUFACTURING EXERCISES

Mastery Exercise Name	Description of Exercise	Number of Work Samples
Automation Errors - Part 1	Understanding actions to take for errors that show on automation equipment	18
Automation Errors - Part 2	Understanding actions to take for errors that show on automation equipment	17
Canon Definitions - Part 1	Canon Stepper specific terminology	16
Canon Definitions - Part 2	Canon Stepper specific terminology	17
Canon Definitions - Part 3	Canon Stepper specific terminology	23
Canon Stepper - Part 1	Recovery from Error section of the Canon Operations Manual	20
Canon Stepper - Part 2	Job Setup & Execution from the Canon Operations Manual	14
Canon Stepper - Part 3	Machine Component & Material Flow Understanding	19
Charts	SPLs - Reading and understanding TAKT DATA and TSCHARTV	13
KLA Reboot & SEM Gauges	SPLs - Checking gauges on the Hitachi 8820 SEM & KLA Reboot Procedure	11
Metrology Basics & Canon System Check	SPLs - relating to Canon i4 Systems Check, Surfscan, Profilometer, Prometrix	21
Photo Area - General	SPLs - Communication, Cleaning machine, Organization, Qual and Maintenance	20
Quals	Procedures for Quals on the Canon Steppers i4 and iW	24
SPC Charts	SPL - Concerns reading and understanding SPC charts and trends analysis	25
TEL Track - Part 1	Operations Manual and SPL Resist Bottle Change	20
TEL Track - Part 2	SPLs - Dummy Dispense and Suckback Check, Wafer Count Adjustment	13
TEL Track Glossary - Part 1	TEL Track specific terminology	19
TEL Track Glossary - Part 2	TEL Track specific terminology	19
Wafer Fab Glossary - Part 1	Selected terminology related to Photo from Wafer Fab Glossary	20
Wafer Fab Glossary - Part 2	Selected terminology related to Photo from Wafer Fab Glossary	20
Wafer Fab Glossary - Part 3	Selected terminology related to Photo from Wafer Fab Glossary	20
Wafer Fab Glossary - Part 4	Selected terminology related to Photo from Wafer Fab Glossary	20
Wafer Fab Glossary - Part 5	Selected terminology related to Photo from Wafer Fab Glossary	20
Wafer Fab Glossary - Part 6	Selected terminology related to Photo from Wafer Fab Glossary	20
Wafer Fab Glossary - Part 7	Selected terminology related to Photo from Wafer Fab Glossary	25
Wafer Fab Glossary - Part 8	Selected terminology related to Photo from Wafer Fab Glossary	24

Each Mastery Exercise related to one of five areas for the purpose of qualifying the workers. Each worker in the E Group built a track record demonstrating competency for all of the Mastery Exercises in an area. The worker then reported to the shift leader. The shift leader confirmed the worker's identity and called up a qualifying Exercise. This qualifying Exercise randomly drew work samples from all of the area.



The chart above shows the progress of workers in one E Group shift. See how they begin to develop proficiency and achieve mastery with the assigned Mastery Exercises. Each line represents a worker. Notice that one took as long as 13 weeks to achieve mastery. Another did it in seven weeks. This is typical when focus is on the output of training (learning and proficiency) rather than on the input (time, cost, effort, or mode).

When all the E Group had qualified, the Workers in the C Group demonstrated their proficiency in these same areas by taking the qualifying Exercises on the SWGPAS. These workers in the C Group were already trained and certified. This was done using conventional recommended methods of training (classroom, computer-based with CD-ROM, on-the-job) and certification (written test with hands-on performance confirmed by supervisor).

Management generally accepts certification of job knowledge and skills as measuring the ability to do a job well. How good a job is certification doing? Does it help the bottom line?

Arguments used for and against certification make a lot of assumptions. Only hard data can show clearly what certification does and does not do for proficiency, productivity and profit. This requires a practical and precise way of measuring worker job proficiency (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.**

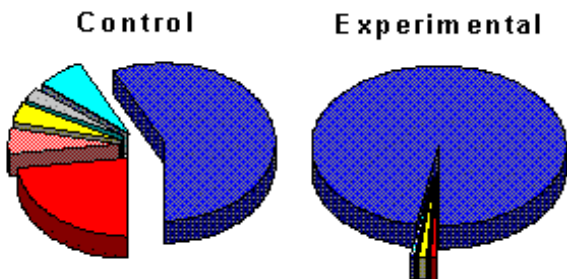
It also requires a controlled experiment. Here, two shifts of a manufacturing department made up the Control (C) Group. The other two shifts made up the Experimental (E) Group.

After screening, revision, and approval by the department staff, 498 work sample problems made up 26 Mastery Exercises.

SWGPAS reveals the correct solution after each work sample problem is solved. It also gives a Problem Status.

STATUS	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 graphs below compare the Problem Statuses revealed on the Qualifying Exercises by the two groups. Remember that the C Group used standard manufacturing hands/on training and hands/on certification practices. The E Group utilized the departmental SWGPAS.



The deficiencies revealed in the C Group are surprising and the cause great of concern. The high level of proficiency achieved by the E Group is not surprising considering that the workers had clear-cut goals set before them. Also they could watch the growth of their proficiency and see the impact of their efforts.

Each Qualifying Exercise is a random selection from the work sample problems of the related Mastery Exercises. So these results indicate that on average each worker in the E Group had five *misunderstandings* (in deep red) on the 498 work sample problems. On average each worker in the C Group had over 120 *misunderstandings* (deep red). Each *misunderstanding* (deep red) is potentially an accident waiting to happen. On the other hand, everyone being *assured* (dark blue) on every work sample problem suggests they will act quickly and correctly, even under stress, when similar problems occur on the production line. To the extent this happens, productivity can improve through increased yield and reduced cycle time.

SWGPAS also tracks a scaled measure of proficiency. This scale has a zero point corresponding to the *undecided* diagnosis. The measure ranges on up to 100% proficiency representing mastery. Unlike other performance measures, it also goes down into the -100% or more range in order to allow for the negative impact of *misunderstandings* and being *misinformed*. Ineptness can more than offset the advantage of a skill. Viewed this way, the C Group shifts averaged 25% and 33%. The E Group shifts averaged 97% and 96%. This striking contrast in measured proficiency suggests that operational differences may exist between those with hands-on training and certification versus those helped by the SWGPAS.

SWGPAS clearly had a major impact upon proficiency on the included tasks and procedures. If these play an important role in production, differences in proficiency can make a difference in manufacturing. Did using SWGPAS change the departmental production statistics? How did these changes, if any, compare with those occurring for the shifts using conventional on-the-job training and certification? They clearly had a major impact upon proficiency on the included tasks and procedures. If these play an important role in production, differences in proficiency can make a difference in manufacturing. Did using SWGPAS change the departmental production statistics? How did these changes, if any, compare with those occurring for the shifts using conventional on-the-job training and certification?

There were no statistically significant differences among the rate of manufacturing operations for the shifts. These may reflect manufacturing schedules and thus be rather inflexible. On the other hand, it may be that it may take a while to adjust procedures to reap the benefits from the new higher levels of job proficiency. Changes in number of units reworked by the department were statistically significant beyond the .01 levels for both the E Group (31% decrease) and for the C Group (29% increase). Changes in the number of units scrapped by the department were statistically significant beyond the .01 levels only for E Group who showed a 20% decrease.

It is useful to know what will happen over the course of a full year when all four shifts have access to a SWGPAS. Then all can maximize and maintain their proficiency at this new high level. Assuming that the percentage gains will stay the same we can calculate the expected gains. Reducing rework 31% and scrap by 20% in this manufacturing department would yield a productivity increase amounting to about \$30,000 per year per participant.

This study yields three major findings –

- **Conventional training and certification techniques yielded proficiency levels of about 30%. Successful completion of courses and certification tests is no guarantee of proficiency on the job.**
- **Using a SWGPAS to perfect learning did result in near 100% proficiency levels in all participants. This is a new way to refresh and to improve proficiency.**
- **These increases in proficiency led to a 31% reduction in rework and a 20% reduction in scrap amounting to production increases worth \$30,000 for each participant. When training does produce mastery it can prove to be a rewarding investment.**

This first look at the value of certification shows that it is discouragingly low. It is no longer prudent to assume without proof that certification assures high levels of performance and prevents mistakes.