TRAIN PEOPLE BETTER: DELIBERATE PRACTICE WITH SIMULATION

INTRODUCTION

Volvo Construction Equipment recently conducted an important study of aggregate operations at a large American quarry to investigate wheel loader operations [Volvo 2015]. A total of 73 wheel loader operators were studied over many days at the controls of three identical (Volvo) wheel loaders doing identical work.

"Clearly, operators are integral to the success of any job. A good operator can make a tired machine perform; a bad one will soon destroy the best machine. Operator competence directly contributes to the quality of work and ability to get a job done on time. In addition, the operator influences downtime and running costs. Tire wear and fuel efficiency rely a great deal on the operator."

Interestingly, the operators were asked to rate their own proficiency using the categories "Average" or "Expert", and the following table presents the variability in operator productivity, as measured by Volvo.

Operator Classification by Skill	Variability in Productivity
"Worst" to "Best"	700%
All "Average"	300%
All "Expert"	100%

Such variability in skill is, unfortunately, typical as represented by the black line in the Figure 1. Why is this so, and what can you do about it? To answer these questions, let's begin by looking at how people learn.

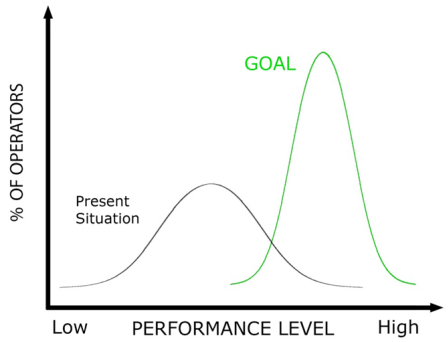


Figure 1.
The black line represents a typical distribution of operating skills. The green line represents a desired distribution, with reduced variability and higher average performance.

HOW PEOPLE LEARN NEW SKILLS

Learning any new skill, including operating heavy equipment, takes place in three stages as described by [Ericsson 2006]:

- Phase 1: People work to understand what needs to be done, and focus on doing their best while avoiding "gross mistakes", i.e. being careful.

- Phase 2: After sufficient practice, people make fewer mistakes, their performance is "smoother", and they no longer focus as intently to do things right.

- Phase 3: Training typically ends when people attain a safe and minimally competent level of performance. In particular, during this third phase of learning, performance become automated, i.e. people now execute skills with minimal mental effort, and performance reaches a stable plateau.

For further improvement, Ericsson proposes what he calls "deliberate practice", described in [Ericsson and Pool 2016] as follows:

- Deliberate practice means learning new

skills by building on previously-acquired skills. Practically, this means learning component skills sequentially, using representative training tasks that gradually present work of increasing difficulty. In a nutshell, deliberate practice is goal-directed work with clearly defined targets.

- Deliberate practice pushes you outside your "comfort zone", to do things just beyond your current abilities. This requires "near-maximal" effort and your full attention.

- Deliberate practice is all about feedback, at first from your trainer/instructor/coach. But later, you learn to monitor yourself, notice your own mistakes, and adjust accordingly. Think of this as "attentive repetition" [Coyle 2009].

We can summarize the key ideas in this way [Coyle 2009]:

learning new skills ← deliberate practice ← concentration ←interest and motivation

In contrast, many people still believe that just doing something often enough necessarily means that you'll get better at it. But as noted in [Ericsson and Pool 2016]:

> "Doing the same thing over and over again in exactly the same way is not a recipe for improvement; it is [instead] a recipe for stagnation and gradual decline."

And this is why, once people learn to do something well enough, they rarely improve, because they are "playing" instead of "practicing" (on the golf course, in the ice rink, at home with the chessboard, etc.).

ABOUT DELIBERATE PRACTICE WITH SIMULATION

At Simlog, we completely subscribe to the notion of deliberate practice, and that's reflected in the instructional design of our training simulation software:

- Component skills are taught sequentially, with simulated versions of real world tasks we call "Simulation Modules".

- Learning is goal-directed, with each module presenting work that is just a little harder to do, to help maintain interest and motivation.

- For each module, performance is measured in a comprehensive way, using "Performance Indicators" associated with how quickly and how carefully you work.

Indeed, recent research has documented the superiority of learning to load a (simulated) truck using a (simulated) hydraulic excavator "bit by bit" using "part tasks", instead of trying to assimilate all the component skills at once as part of a "whole task" [So et al. 2012].

A SIMLOG EXAMPLE: HYDRAULIC EXCAVATOR

Now let's look at Simlog's Performance Indicators for the truck loading Simulation Module that we call "Trench and Load", in light of the three phases of learning presented earlier.

In Phase 1, trainees are primarily concentrating on moving material from the trench to the truck box by carefully filling the bucket, swinging to the truck, clearing the side board, and then emptying the bucket into the truck box. The key Performance Indicators here are measures of how the bucket and stick are positioned for optimal digging (Initial Bucket Alignment, Initial Bucket Attack Angle, Initial Stick Angle), how carefully the digging takes place (Volume of Material Dug Outside Digging Target), and avoiding any collisions with the truck (Bucket and Truck, Boom/Stick and Truck) that would

constitute “gross mistakes”.

In Phase 2, trainees are now encouraged to pay attention to other Performance Indicators associated with “doing better”. One example is related to the how the bucket is positioned for dumping by measuring the falling distance of the material from the bucket to the truck box (Average Falling Distance of Dumped Material). In this way, trainees learn to just clear the sideboard when swinging to the truck, to keep the bucket low to better control how the material falls into the truck box and at the same time improve productivity. Clearly this requires more skill, and that’s why in Phase 1, this Performance Indicator is largely ignored. Another way of “doing better” is by reminding trainees to dig “evenly” in accordance with the simulated stakes so that the “floor” of the trench is at the required depth and is flat (depth is constant), thanks to two other Performance Indicators (Trench Depth Variability, Volume of Trench Over-Digging).

Finally, in Phase 3, trainees “come up to speed” after learning to do everything carefully, so the focus turns to the Performance Indicators associated with time (Execution Time, Productivity), while “monitoring” the Performance Indicators that were important for Phases 1 and 2.

Clearly, the presence of so many Performance Indicators (there are a total of 18 just for this module) means that trainees are progressively “challenged” to do better by having them pay attention to more and more elements in their simulation results, i.e. by having them shift the focus of attention as they improve the values of the Performance Indicators that measure different aspects of the simulated work.

Moreover, for each simulator session, simulation results are presented as average, minimum, and maximum values for each Performance Indicator for the associated Simulation Module.

In this way, as you continue to train, average values become better and the differences between minimum and maximum values (between the best and worst cases) become smaller, i.e. consistency increases with skill.

DELIBERATE PRACTICE AND SUSTAINING FOCUS

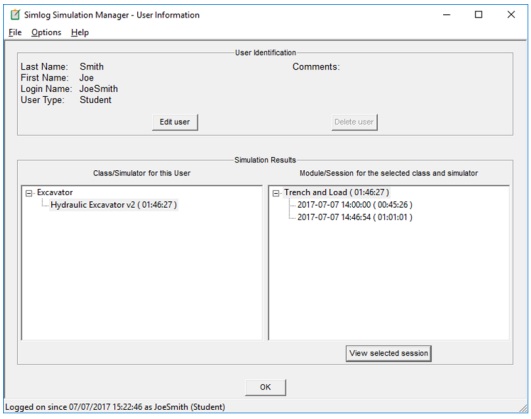
As previously noted, deliberate practice requires “attentive repetition” [Coyle 2009], but it’s hard to remain attentive for “too long”. And for that reason, Simlog recommends that the duration of each simulator-based training session be limited to 45-60 minutes. (Of course typical training programs are already organized in this way, with trainees moving from subject to subject, and sometimes from place to place, every 45-50 minutes.)

On the one hand, if the duration is too long, people lose focus and no longer practice in a “deliberate” way. On the other hand, if the duration is too short, achieving the desired level of proficiency will be too “spread out” in time and require too many sessions, complicating the organization of the simulator-based training.

Practically, interactivity is key to maintaining focus. Indeed, research suggests that playing video games can actually increase attention span, as people “lose themselves” in the back-and-forth about doing something and then dealing with the immediate consequences. One such study documented notable improvements in attention span thanks to playing a customized video game one hour a day over three weeks [Anguera et al. 2013].

DELIBERATE PRACTICE AND SIMULATOR-BASED TRAINING

At Simlog, our Personal Simulators are designed



to provide hours and hours of simulator-based training value. Stated differently, a typical trainee might need 40-60 hours or more to do as well, at the simulator, as an expert. (Remember that what's important is achieving the target level of proficiency, however long that might take.)

Practically, this means that for each Simulation Module, there will be multiple sessions (of 45-60 minutes), to ensure that there is enough repetition to gain the desired level of proficiency.

And to that end, Simlog's Simulation Manager features functionality that automatically "counts" (adds up) the amount of simulator-based training time over all the sessions for each Simulation Module. In this way, it becomes easy to see, at a glance, how much simulator-based training has taken place.

In the example shown here, the trainee has completed two sessions of the "Trench and Load" Simulation Module. The duration of the first session was 45 minutes and 26 seconds, and the duration of the second session was 1 hour, 1 minute, and 1 second, so the combined (total) simulator-based training time was 1 hour, 46 minutes, and 27 seconds.

CONCLUSIONS

We now know that the best way to learning new skills is to practice in a "deliberate" way that requires concentration that shifts from working carefully to avoid mistakes, to working quickly while still working carefully.

And at Simlog, this is reflected in the instructional design of our training simulation software:

- Component skills are taught sequentially, with simulated versions of real world tasks we call "Simulation Modules".
- Learning is goal-directed, with each simulation module presenting work that is just a little harder to do, to help maintain interest and motivation.
- For each module, performance is measured in a comprehensive way, using "Performance Indicators" associated with how quickly and how carefully you work.

But deliberate practice requires "attentive repetition and for that reason, Simlog recommends that the duration of each simulator-based training session be limited to 45-60 minutes. And thanks to Simlog's Simulation Manager, it's easy to keep track of all the simulator-based training.

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