Spotting Potential in Crane Operators
(pre-screening *before* training)

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Crane Safety
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Presentation Outline

- variability in operator performance
- differences in "natural abilities"
- evaluating natural abilities
  - "psycho-metric" testing
  - simulation
- Simlog experience
- conclusions

Your People = Your Bottom Line (1)

"There is a saying: there are part-changers, and there are *mechanics*.

"Operating a crane is similar: there are lever pullers, and there are *operators*."

Your People = Your Bottom Line (2)

"How your people operate your equipment has, without a doubt, the greatest impact on your operating costs.

"The fact is, data clearly shows that good operators run their machines better, more productively, and more cheaply because they understand their machines better, and know how to maximize production without over application and abuse."

Characterising Operators
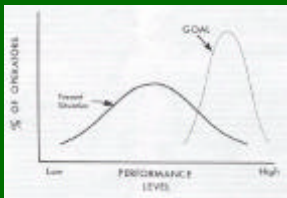
Everyone an Athlete?
Everyone a Crane Operator?

- although "practice makes perfect" when learning skills, some people:
  - learn faster
  - attain higher levels of proficiency
- why is this so?
  - differences in "natural" abilities

Looking at Human Differences

- better understand the relationship between natural abilities and:
  – on-the-job performance
  – "trainability" (training suitability)
- evidence suggests that up to 30% of typical heavy equipment operator training candidates lack the necessary natural abilities to become fully proficient at the controls!

Key Human Abilities

- "psycho-motor" ability associated with manual dexterity and hand-eye coordination, i.e. moving arms/hands/fingers (and feet) at the same time
- "perceptual" and "cognitive" abilities associated with depth perception and thinking about spatial orientation, i.e. seeing things at a distance, knowing and keeping track of what's in front, what's behind, and what's around you

Standardized Testing (1)

- once we've identified key human abilities, we want to find out if people have them in order to help *evaluate* "trainability" and *predict* future job performance
- call upon "surrogate work" which can be easily measured and correlates with doing the real work well
- standardized content, delivery, and scoring

Historial Perspective

Focus on "Accident Prevention"

- evaluation of operator training candidates for the RATP in Paris (1935!)
- measuring reaction time (hands, feet) in response to visual and auditory stimula

Focus on "Enhanced Job Performance"

- popularized by industrial psychologists after WWII for the "blue collar" (factory) workforce

Standardized Testing (2)

- *predictive* validity:
  – good [poor] test score is predictive of good [poor] on-the-job performance
- *face* validity (credibility):
  – measure of how genuine or *convincing* the test is perceived to be by the training candidate
- *construct* validity:
  – people who do the real work well have better test scores than people who do the real work poorly
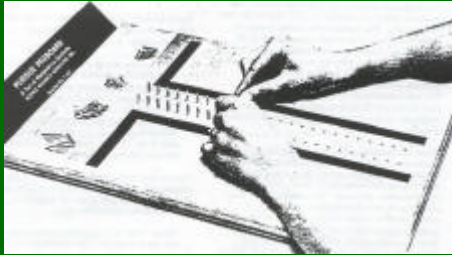
General Aptitude Test Battery

- developed by U.S. Employment Service in 1948
- 12 categories to evaluate 9 "aptitudes" including:
  – manual dexterity and hand-eye coordination
  – spatial reasoning

[also numerical aptitude, verbal aptitude, etc.]

Testing Manual Dexterity and Hand-Eye Coordination
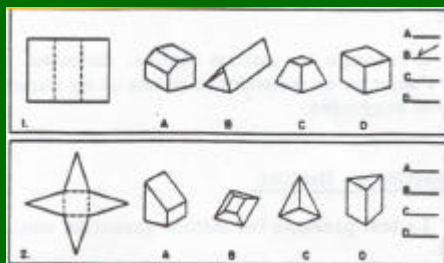

Test Weaknesses

- task performance is only measured in terms of "productivity" (speed), not "quality"
- typical work with real cranes also requires attention to detail, even when working "quickly"

Testing Spatial Reasoning

Test Weakness

- task only measures how well your brain works, not how well your brain *and* vision system work together
- typical work with real cranes means "seeing" *and* "reasoning" about objects that are far away!

Comparing Psycho-metric testing with (Simlog) Simulation

- students and trainers at a Canadian forestry school, in collaboration with two universities
- three ways of evaluating human differences:
  – psycho-metric test for manual dexterity and hand-eye coordination
  – psycho-metric test for spatial reasoning
  – (Simlog) simulation

Simlog Test Results (1)

- manual dexterity and hand-eye coordination:
  – wide variation in student scores
- spatial reasoning:
  – even wider variation in student scores
- good correlation between tests:
  – do well on one, do well on the other
  – do poorly one one, do poorly on the other

Simlog Test Results (2)

- simulation:
    - wide variation in student scores
- only *partial* agreement between psycho-metric tests and simulation: for some students, do well on the tests but poorly on the simulator (never vice versa)

Simlog Test Results (3)

Simulation judged to be the *best* predictor:
- poor simulation results *always* meant poor on-the-job performance doing the real work
- although everyone's score continued to improve as the simulator-based work continued, "poor" students fell further and further behind
- simulator-based identification of those "poor" students becomes *statistically possible* after just a few hours!

Why (Simlog) Simulation is Best

Psycho-metric tests *can* be used to evaluate *individual* human abilities, but only simulation can properly evaluate the *combination* of human abilities associated with doing the real work well in a synergistic way.

Final Comments
(from an industrial psychologist)

"Traditionally, an industrial psychologist attempting to measure the key competencies or aptitudes needed to operate the [harvester] machine would employ a battery of tests that would include three-dimensional perceptual ability, depth perception, hand-eye coordination, and mechanical aptitude. It is clear that Simlog's [harvester] simulation does a *superior* job of measuring these key competencies. In addition to saving time and costs, testing and training candidates on the simulator is more likely to measure an individual's true abilities because people are less fearful and nervous about making real-life errors."

Larry Stefan, Ph.D., L. Stefan and Associates (Vancouver, B.C.)

Simulation for Pre-screening
(Simlog style)

- feedback is immediate
- scoring is comprehensive and combines
    - *productivity* measures
    - *quality* measures

Personal *Mobile* Crane Simulator
"Executing Lifts"
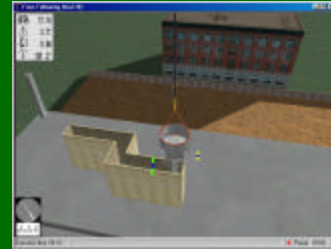
Performance Criteria

Results for trial 1
- Success: Yes
- Execution time: 1:11
- Maximum load ratio: 0.460
- Number of two-block's: 0
- Number of collisions: 3

Personal *Tower* Crane Simulator "Form Following"

Performance Criteria

Module "Form Following"
Results for trial 24

Elapsed time	1:08
Maximum height error	0.3 m
Time outside height range	0:01.1 (1.6%)
Maximum lateral distance error	3.4 m
Time outside wooden form borders	0:33.4 (49%)
Number of collisions	0
Time spent colliding	0:00
Number of fatal collisions	0

Press the Trial Advance button to continue

And today's "video game" kids?

Many (most?) people believe that the "video game" kids of today will *necessarily*:

– learn to operate heavy equipment better

– go on to achieve higher levels of proficiency at the controls

Simlog knows better!

- yes, "video game kids" do *begin* more quickly at the simulator and in the cab of real equipment, but only because they better anticipate the behaviour of the operator controls
- no, they do *not* learn faster
- no, they do *not* become better operators

Why is this so?

- video games are little more than elaborate psycho-metric tests of manual dexterity and eye-hand coordination
- predicting operator potential also requires evaluating perceptual and cognitive abilities, and in a "synergistic" way
- the right kind of simulation does that job best!

Conclusions

- there exists a wide range in operator performance (and machine repair costs and safety records), even in situations where work conditions are relatively uniform
- the increasing costs of owning and operating equipment means that the financial *consequences* of these differences are more important than ever
- time to pay attention to differences in natural abilities
- the *right* kind of simulator can help, but must be careful about complexity and cost!