League-Stepping Habits as an Escape Route (Thru Plateaus, Dips, and Leaps) From Stable Suboptimal Performance: 
A Behavioral Marker Approach

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See Marc’s talk at 14:10 tomorrow

*Disrupting the Grind: Case Studies in Strategy Insight.*
Outline

1. Introduction
2. Plateaus of Performance
3. Mere Expertise is Not Good Enough
4. Plateaus and Asymptotes
5. Escaping Performance Plateaus by Acquiring League Stepping Habits
6. Dips and Leaps Mark the Spots Where Research Must Focus
Bryan and Harter (1899) who claimed that experts were not simply faster than novices, but had developed a hierarchy of habits than enabled them to *step leagues* while novices were *bustling over furlongs or inches* . . . 120 years ago . . .

**FOOTNOTES**

A “league” is an old English measurement corresponding to about three miles (4.83 km). However, the connotation of a continuous measured advancement is deceptive, at least with respect to learning. Here, we use the term “league” in a more vernacular sense, to connote a distinct change in quality, as in, “She’s out of his league.”.

A “furlong” is an old English measurement corresponding to about 220 yards (201.2 meters).
Nearly 30 years ago, the HCI and CogSci communities were both seized with concerns over performance plateaus (i.e., extended periods of stable suboptimal performance) from experts. For HCI this was viewed as a systems problem and referred to as the *Paradox of the Active User*. CogSci diagnosed this as a training problem and embraced *Deliberate Practice*. 
STATE-OF-THE-ART: Cognitive Science as the Little Engine that Could

- The CogSci Engine is chugging slowly along . . .
- Advances in theories of performance are dominated by more and varied examinations of the log-log law of learning.
- Deliberate Practice attempts to emphasize and codify best practices in various domains, one by one . . .
- Our destination lies over this mountain and we think we can, we think we can, get to it this way . . .
- But maybe we don’t need to. Maybe there is a way around it instead?
What we do not research enough is strategy discovery
What we do not research enough is method development
These are the keys to understanding extreme expertise
THE CURRENT STATE OF PRACTICE?

- For some domains the strategies that must be taught for extreme expertise have tested and tweaked; for example,
  - Many music domains

- But for the vast majority of domains, the only advice for practice that the popular press has gleaned from CogSci research has been *work hard!*
Plateaus vs Asymptotes:
- Review of history
- Distinguish between *performance plateaus* and *asymptotes*

Behavioral Markers:
- *Plateaus, Dips, and Leaps* in individual performance
- Mark periods of *performance change for individuals*

League Stepping Habits – for the researcher:
- Dips mark transitional phases of performance
- Methods developed during dips may provide performance leaps
- Leaps signal the adoption of new *League Stepping Habits*.
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Hypothesized that telegraphic expertise consisted of a hierarchy of habits.

*Plateaus* were periods in which elements at one level of the hierarchy were being combined so as to be used at a higher level.

dots and dashes $\rightarrow$ letters $\rightarrow$ words $\rightarrow$ phrases
“I venture to prophesy that the thousand bookkeepers in, say, the grocery stores of New York who have each had a thousand hours of practice at addition, are still, on the average, adding less than two-thirds as rapidly as they could, and making twice as many errors as they would at their limit.”

“It appears likely that the majority of teachers make no gain in efficiency after their third year of service, but I am confident that the majority of such teachers could teach very much better than they do.”

“It seems to me therefore that mental training in schools, in industry and in morals is characterized, over and over and over again, by spurious limits – by levels or plateaus of efficiency which could be surpassed.”

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In 1987, Carroll and Rosson coined the term, *Paradox of the Active User*, to refer to the “suboptimal use of office productivity software” by people who use the systems daily across the course of weeks, months, and years.

Carroll and Rosson, who at that time worked for the IBM Watson Research Center, shared the HCI community’s concern that the expected productivity gains of the computer revolution were not occurring.
A few years later, based on his studies of human expertise, Ericsson (1993) concluded that, “the belief that a sufficient amount of experience or practice leads to maximal performance appears incorrect”.

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After years of lurking in the background, the plateau had returned to front and center.
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Human performance had *asymptoted* due to the design of the task environment; namely, the pole.

- Changes in the composition of the pole from ash (wood), to bamboo (wood), to fiberglass/carbon
- Each technology, enabled pole vaulters to break new records
- Followed by invention of new methods that resulted in new rounds of record breaking as those methods were adopted and adapted by athletes.

Asymptote $\rightarrow$ New technology $\rightarrow$ New methods $\rightarrow$ Asymptote
Human performance had *plateaued* as the limits were due to the techniques used, not to inherent limits of human performance.

Method – *Fosbury Flop* could have been invented earlier.

Plateau $\rightarrow$ New Method $\rightarrow$ New Plateau

The *Scissors and Straddle* technique for high jumping.

The *Fosbury Flop* technique for high jumping.
How do plateaus and asymptotes come about??

Asymptotes due to:
- Artifact Design
- System Design
- Measurement Method (false asymptotes)
Crossman’s (1959) study of cigar rollers in Cuba. Plot shows a continued increase in performance over a two year period (estimated as 3 million cigars) and then a flattening of the curve.

Newell and Rosenbloom (1981, p. 7) attribute this flattening to a “known lower bound for the performance time” in this task; namely, the “cycle time of the machine.”
A field trial of two workstations for Telephone Operators (Gray, John, & Atwood, 1993).

Expected call times to decrease across the 4-mon trial.

But after 2-mon worktimes stabilized with times per call slower than for the old workstation

Slow enough to increase annual operating costs by $6.2 million (in 2014 dollars).

Diagnosis:

- Designers believed call time driven by the # of keys-per-call.
- Predicted savings of 4.1 s in mean item per call for annual savings of $24m.
- BUT cognitive modeling showed that old workstation enabled Operators to interleave keypresses, chats with customer, and wait time for external databases.

Conclusion:

- Based on the models, Operators were becoming more expert at the new workstation but asymptotes due to systems design prevented these gains in expertise from yielding performance increments.
Example from Space Fortress in which a measurement method was introduced about 1994 that has affected many of the conclusions reached by researchers ever since.

To simplify the story . . . changed scoring so that it included 4 component scores and one overall score. These measures can be shown to be (1) not independent of each other and (2) two of these measures asymptote even as skilled performance increases.
The Digit Span Task – An important part of the Wechsler Adult Intelligence Scale (WAIS) IQ test (and others).
- Digits (0-9) are read at the rate of 1 per sec.
- Followed immediately by ordered recall.
- If all digits were recalled correctly, the length of the next run of digits was increased by 1.
- If all are not correct, the next run is decreased by 1.

The population norm is 7 ± 2.

Is this an asymptote due to limitations built into the human brain? or

Is this a plateau due to massive stable suboptimal performance on the part of the entire human population?
Well? ... This is an IQ test item!! Therefore it MUST be measuring an individual difference variable that differs between humans but is stable, or asymptotic, for any given individual.

Right ... ?
IS HUMAN DIGIT SPAN A POPULATION ASYMPTOTE OR PLATEAU? – PLATEAU!!

- The difference between a plateau and asymptote is made clear by the existence of extreme experts with a known history of transcending the plateau.

Perhaps the human asymptote is $80 \pm 2$ instead... ????
Issue: The difference between a plateau and an asymptote may be hard to determine.

Asymptotes may reflect a problem that can be fixed by design (whether artifact design or system design); however, plateaus due to strategy-induced suboptimality may arise when the strategies deployed do not enable utility maximization in the task environment.

- Overcoming such strategy-induced suboptimality is usually very difficult.
- Example of transfer from visually-guided to touch typing.
- Resolving the paradox of the active user.

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THREE TYPES OF COGNITIVE ACTIVITIES

1. Strategy Acquisition: Discovering or being told a new strategy. Its behavioral marker is the plateau.

2. Method Development: Working out a method or methods that will implement the new strategy and adapt it to variations in the task and task environment. Its behavioral marker is the dip.

3. Practice: The behavioral marker of the early trials of practice on the new method is the leap, which takes performance with the new strategy and method beyond that of the old.
Notional plot of a succession of three performance curves separated by dips and leaps.
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W. Gray (RPI)
Four different methods across \( \approx 100 \text{ hours of practice!} \)

1. “glue my eye to the ball” – worked for a while . . .
2. “peripheral looking” – “I could play through a long volley gluing my eye \textbf{away} from the ball.” . . . “Then the slam.”
3. paddle segments . . . but, “Knowledge about the paddle’s programmed subdivisions and angles no more truly aids the task at hand than a knowledge of physics could help you line up a certain point on a bat with the ball in order to hit to the field.”
4. In the range of about a half inch above the paddle as the ball came down . . . That’s where you had to look, and you had to look somewhere, couldn’t look nowhere . . . I found a looking method.” Unfortunately for Sudnow, in the very next paragraph he tells us, “But it didn’t work.”

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DIPS & LEAPS

- Dip + Leap: *Might* signal the adoption of better strategies and sound methods for implementing those strategies.
  - Dip: *Might* signal an initial decline in performance as variations of new methods are tried on variations of the task.
  - Leap: *Might* signal the development of a method that implements the strategy.

- Dip + Return to Plateau: An ambiguous case
  - ? loss of motivation or fatigue followed by the return of motivation or rest? or
  - *Might* signal a period of exploration that does not result in a new and more successful method, the abandonment of that method, and a return to an earlier one.

- No Dip + Leap: The cost of implementing a new strategy *might* not be great enough to create a dip.
Might!!! – These are behavioral markers of where to look for periods that might signal human attempts to develop, implement, and practice new methods. But they might not!!

However, right now we are not looking at all. Indeed, right now we are not “marking the spot” but what we are doing instead is “missing the point.”
MARKING THE SPOT VERSUS MISSING THE POINT

Tradeoff between averaging over data to extract a performance mean and looking at individual performance.
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Tradeoff between averaging over data to extract a performance mean and looking at individual performance.

![Graph showing the tradeoff between averaging over data to extract a performance mean and looking at individual performance.](image-url)
MARKING THE SPOT? CLOSE?? NOT!!
MARKING THE SPOT? AROUND?? THRU??

![Graph showing the relationship between practice and points over different hours of practice.](image-url)
If “most people and professionals reach a stable performance asymptote within a limited time period” (Ericsson, 2004), then practice does not make perfect.

Unless, as a society, we can be content with “stable suboptimal performance plateaus” then something more is needed. We suggest that this “something more” is research into the acquisition of expertise in mundane (i.e., everyday) task environments.
NOT arguing against ever averaging across subjects.

IS arguing that if you are interested in (a) periods of strategy discovery and (b) in the process of method implementation then you have to take the microscope out and look at individuals during periods of exploration and change.

Dips and Leaps sometimes signals these periods of rapid exploration and change!! Sometimes dips, by themselves, just reflect the wandering of attention, lack of motivation, and so on.

Business-as-usual seems to work fine for bringing the average person up to the average level of expertise – however, going beyond that requires looking for the inventions and discoveries that go beyond the performance levels of the teachers.
100 years ago, researchers interested in strategy discovery, invention, and implementation dropped their keys and have been looking for them ever since *under the lamp of averaging-across-subjects*
It is now time to stop looking for them there and to bring our lamps over to where we dropped them, over here, in one of these plateaus, dips, or leaps.

For an example of this, see Marc’s talk tomorrow at 14:10 – *Disrupting the Grind: Case Studies in Strategy Insight*. 
Thank You!!


