



The *Aha!* Experience and the Joy of Teaching

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Εὕρηκα! is Greek for *Aha!*



Archimedes of Syrakousai needed to measure the volume of an irregular object.

<http://www.cs.drexel.edu/~crrnes/Archimedes/Crown/Virtuino.html>

Aha! is German for *Aha!*

The phenomenon has been recognized and studied for a long time.

- Karl Bühler and *Aha-Erlebnis*
- Wolfgang Köhler's chimpanzees
- Mark Jung-Beeman and John Kounios.

Insight

"Insight" is (probably) a distillation of knowledge and experience.

- Archimedes of Syrakousai and displacement
- Isaac Newton and gravity
- Henri Poincaré and non-Euclidian geometry
- Thomas Edison

Aha! and Novelty

- Novelty is (probably) not a necessary component of insight: the sudden *Aha!* experience.
- Anyway, although a particular idea is not novel, it may be *novel to the student*.
- Students who "get it" can have the *Aha! experience* when the pieces suddenly fit together.

The Importance of *Aha!*

- **To the student:** The *Aha!* experience possibly marks the transition from linear (left-brain?) thinking to associative thinking. It may be the beginning of mastery of a subject.
- **To the teacher:** It's a big part of the reward for teaching.

The Dark Ages (BCS)

- There were few computer science programs in the 1960's.
 - Purdue started a program in 1962
 - UCLA, 1968
 - Also Cornell, Carnegie-Mellon, and a few others.
- Computer programmers were trained at trade schools or on the job...
- ... *by me*, from 1970 to 1974 and later.

The 25-Cent Lesson

On-the-job teaching technique:

- Answer the question at hand.
- Offer a 25-cent lesson in the subject. (Implication: the lesson will be short!)
- The 25-cent lesson was almost always accepted, possibly because it had immediate relevance.
- And, I learned that it gave me joy to help others learn.

The Joys of Teaching

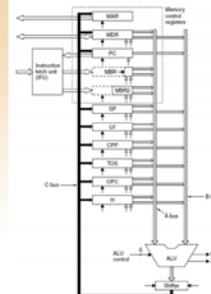
- Teaching is about learning
- About giving the gift of knowledge
- About enjoying the presence of young people
- About the learning breakthrough
 - In the large: helping people understand that they can learn and helping them do it.
 - In the small: the *Aha!* experiences that lead (maybe inevitably) to that breakthrough in the large.

From an article by David Greer

Two *Aha!* Examples

- Computer clocks (Or, what we mean when we say, "A two gigahertz processor.")
- Nanoseconds, which you need to understand to have a full understanding of computer clocks.

The Datapath of a Computer

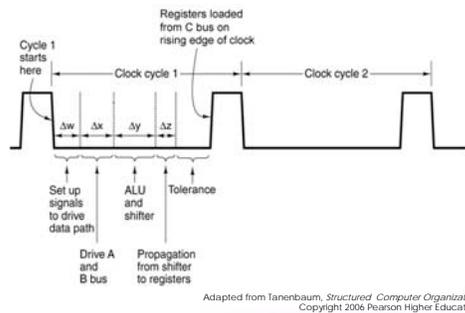


Processing steps:

- Set up control signals
- Bus propagation
- Arithmetic and logic operations
- Bus propagation to destination registers
- Result stored

Adapted from Tanenbaum, *Structured Computer Organization*
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Datapath Timing (The Clock)



What *is* a Nanosecond?

- A billionth of a second. (Not good enough; no frame of reference.)
- An eye-blink takes 250 million nanoseconds. (Still not good enough; the frames of reference are too far apart.)
- Time for one generation in a fission reaction is about 10 nanoseconds. (Unfamiliar frame of reference.)
- ... well then, what ?

A Computing Hero



- Admiral Dr. Grace Murray Hopper
- Sometimes put on a "little old lady" act.
- Once asked a staff member to show her a nanosecond.

Grace Murray Hopper, 1984. Courtesy U.S. Navy.

A Nanosecond is This Long...



- Electronic signals can travel just under a foot in a nanosecond.
- The frame of reference fits the student's physical world and the topic under study.
- Ask one of my students how long a nanosecond is!

Teaching Philosophy

- My teaching approach is:
 - Tailored to the course
 - To some extent, tailored to each student
- I combine theory and application
- I hope to elicit:
 - Critical thinking
 - The ability to generalize for problem-solving
 - A willingness to approach new problems
 - That *Aha!* experience.

Results

- Bimodal grade distribution
 - Many grades of A and some B's
 - A few C's
 - A few D's and F's.
- Consistently good student evaluations (But also bimodal!)
- Very positive personal feedback, even from students who did not earn grades of A.

I'm Really Proud of This!

Debbie Brown,
I never did tell you how much you are appreciated. I thank you for challenging me and staying on my back. I am very thankful that you were able to help me when I was not your current student... when I needed help the most. You are what I call one of the "best professors standing" because you not only spark the interests of your students, but you challenge us! That is what is missing in colleges today. Thank you for all you do! I wanted to get a gift for you. I bought this the other day. I know you don't coffee and it gets cold. I figured you could set it in your office. It was either this or a Britney

Spurs poster is. Thank You again!!
Kelly

I'm Really Proud of This!

"I never did tell you how much you are appreciated. Thank you for challenging me and staying on my back.

"I am very thankful that you were able to help me when I was not your current student... when I needed help the most.

"You not only spark the interests of your students, but you challenge us!"

And This...

"As I graduate from SPSU, I just wanted to share this with you... the classes I enjoyed most were your classes.

"I don't know if you know that I actually took six classes from you! *Six classes!*

"One thing about your classes and your teaching style is that people learn in your classes."

Learning More About Teaching

- Learning from my colleagues
- Learning from reading
- Learning from my students
 - SIRS and other formal feedback
 - Informal feedback
- Trying new techniques
 - Podcasting
 - Student management of "late days"
 - Explicit problem statements for papers (with formative feedback)

