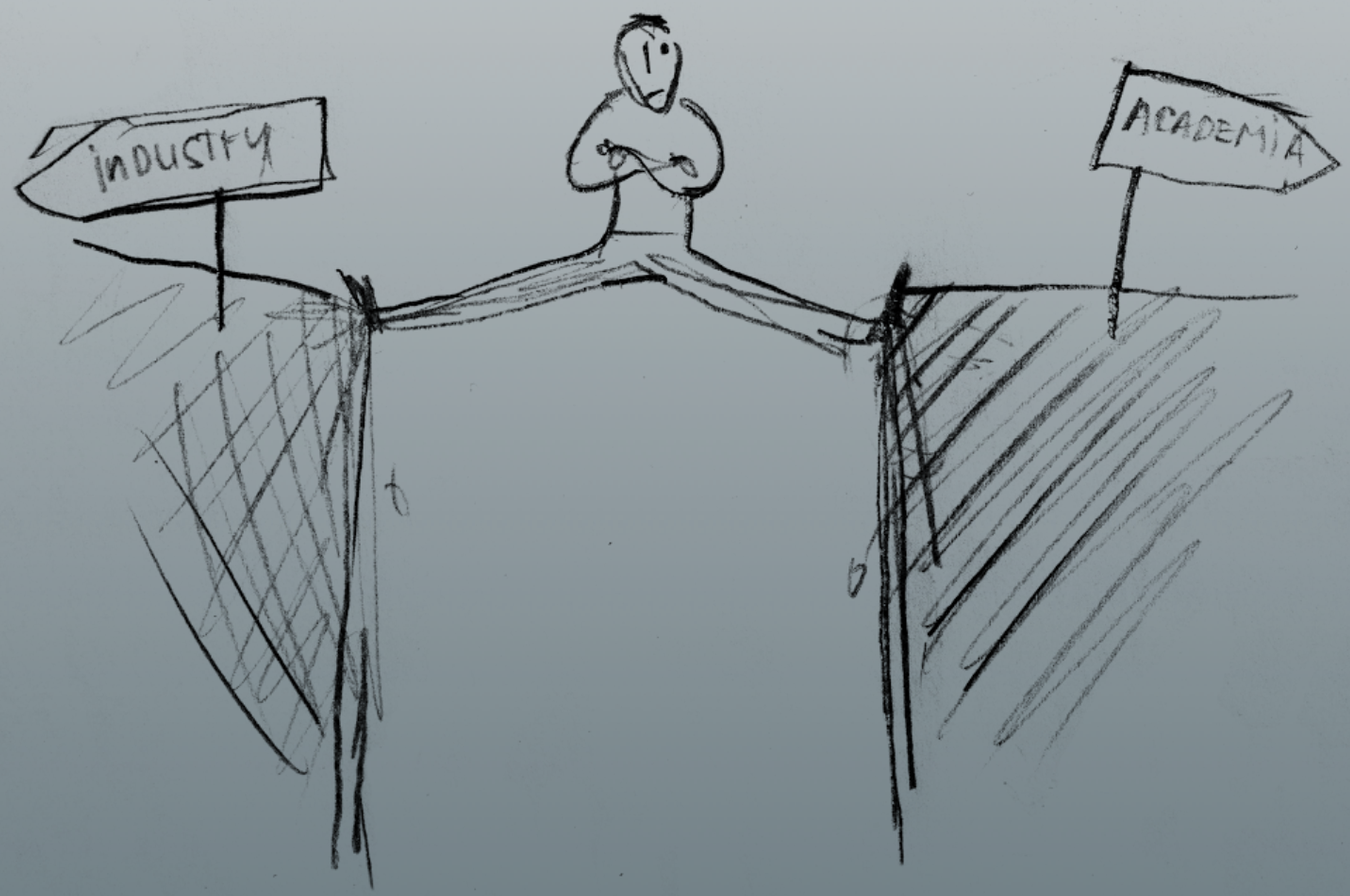
BRIDGING THE GAP

IF NOT CALCULUS, THEN WHAT?

KEITH MERTENS - MAY 3, 2019



THE TALE OF 2 KEITH'S

KEITH THE ACADEMIC

UNM

Colorado State University

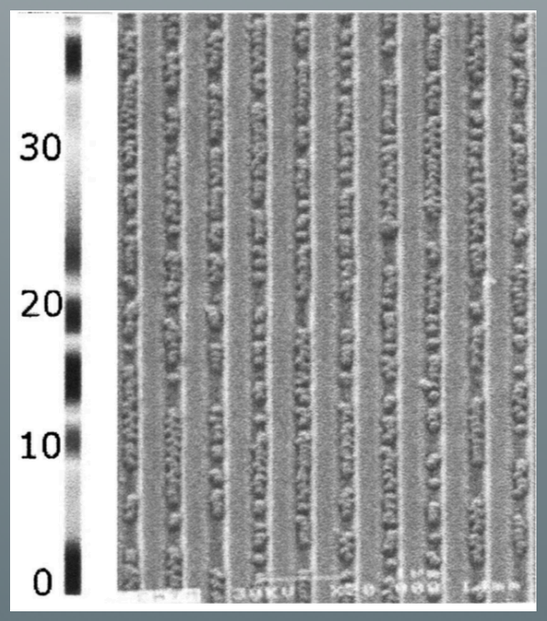
Physical Review Letters

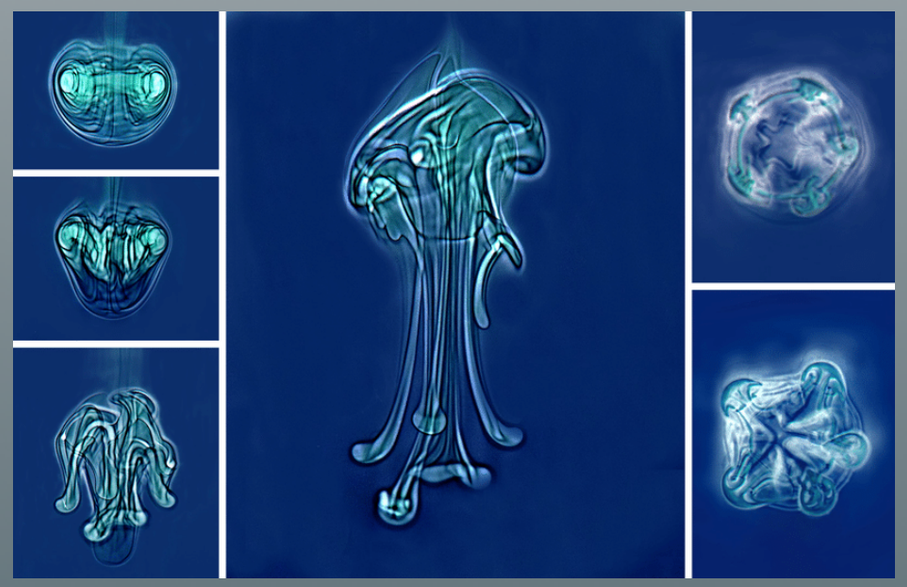
nature
International weekly journal of science

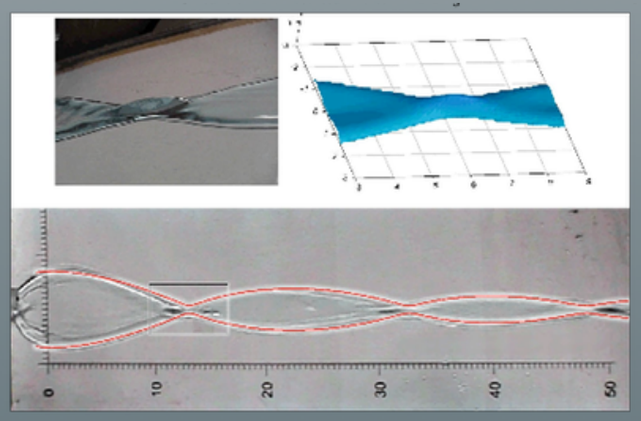
Journal of Fluid Mechanics

Journal of Experimental Biology

AIP



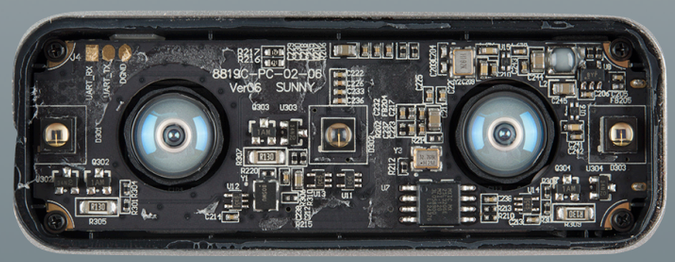


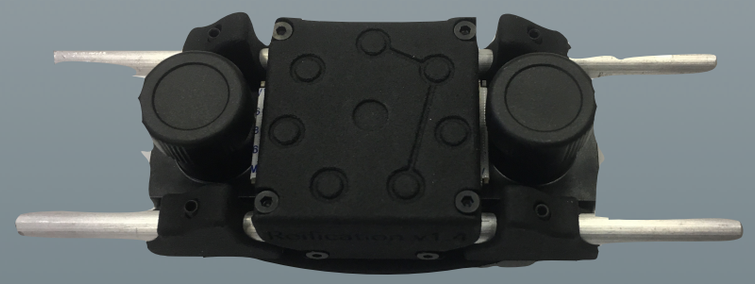


INDUSTRY KEITH

LEAP MOTION

Reification.io





STRUCTURE OF THIS TALK

The skilled labor gap

What exactly is the problem?

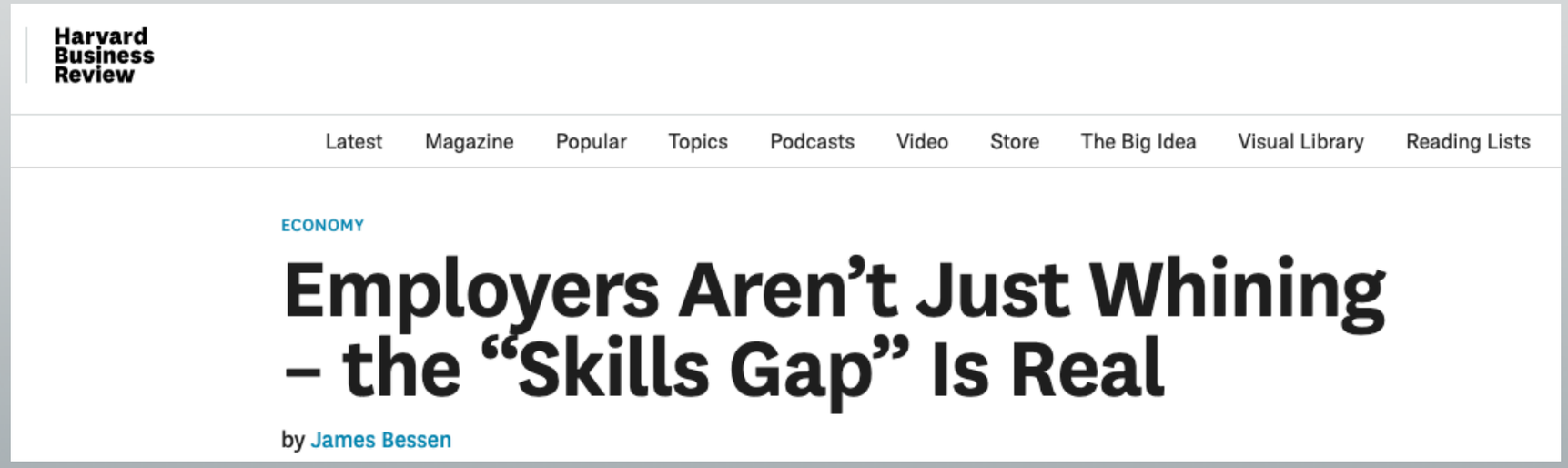
The road that has led us here

How have we ended up in this situation?

Modernizing curriculum

Where do we go now?

THE SKILLED LABOR GAP


Harvard Business Review

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ECONOMY

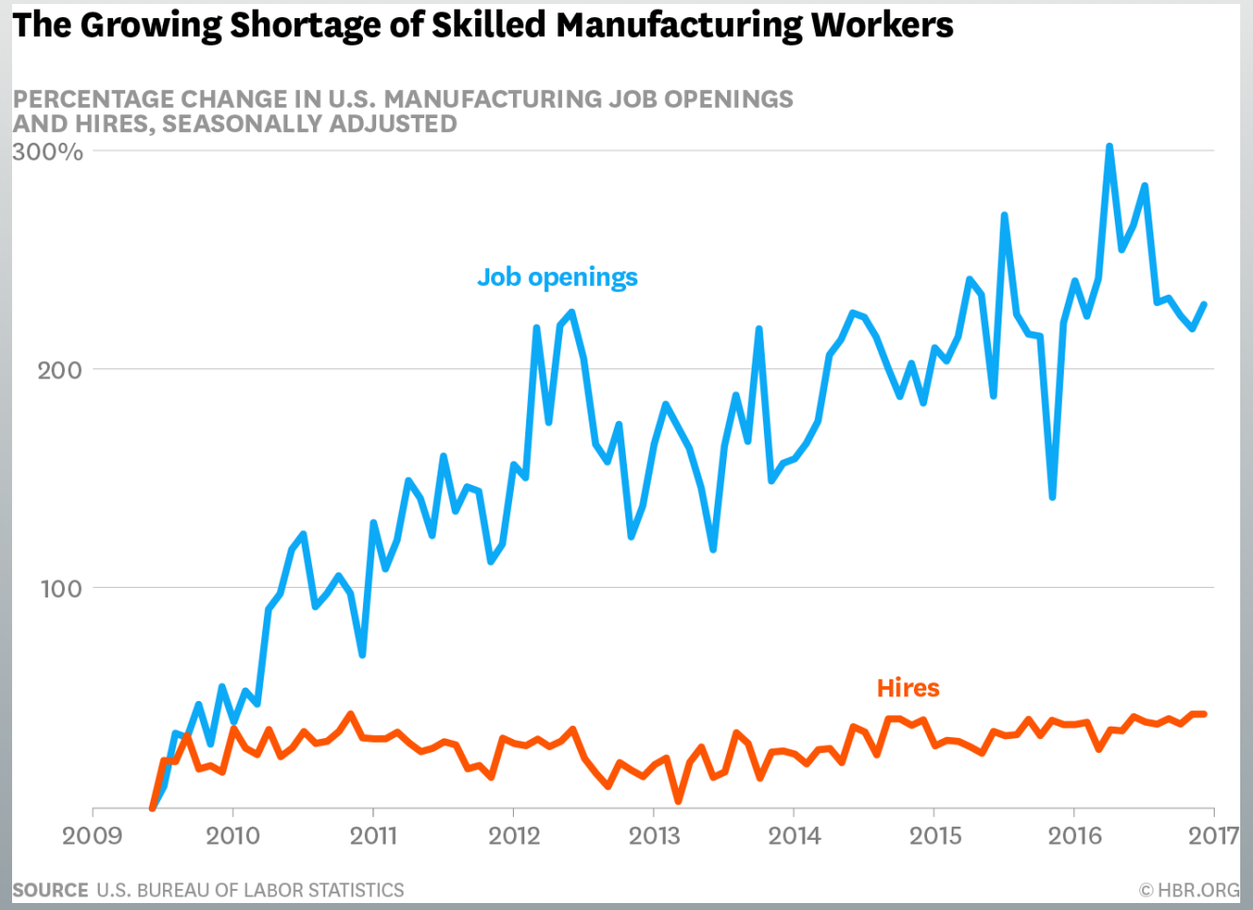
Employers Aren't Just Whining – the "Skills Gap" Is Real

by James Bessen

"…mostly a corporate fiction, based in part on self-interest and a misreading of government data."

92% of sr executives expressed opinion that troubling gaps in skills plague the workforce…candidates lack communication and critical thinking

from "The Skills Gap and the State of the Economy"



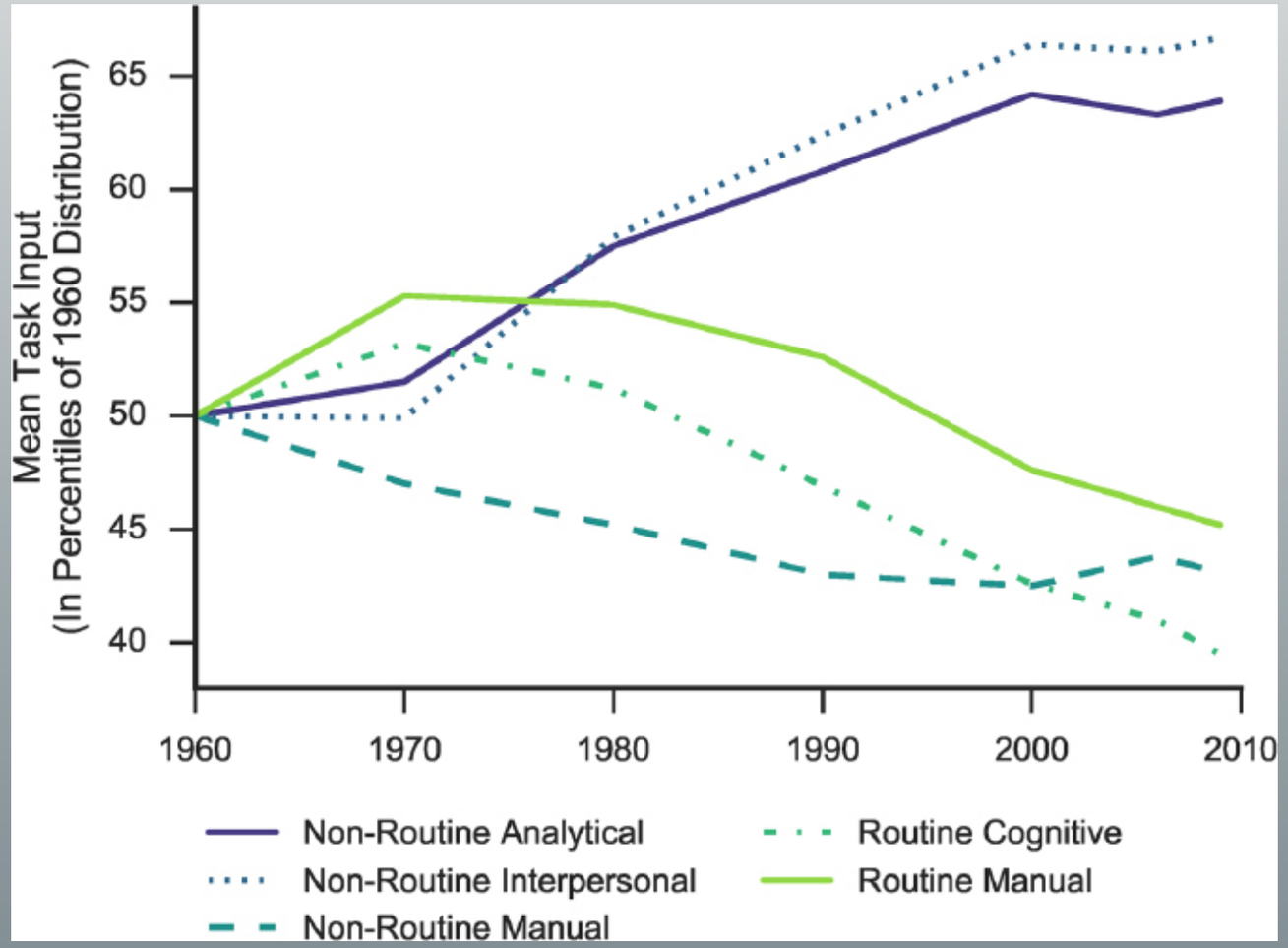
65% of job roles that the children entering primary school today will take up have not yet been created – these will be new types of work

Richard Harpur, London Technology Leaders Summit, 2018

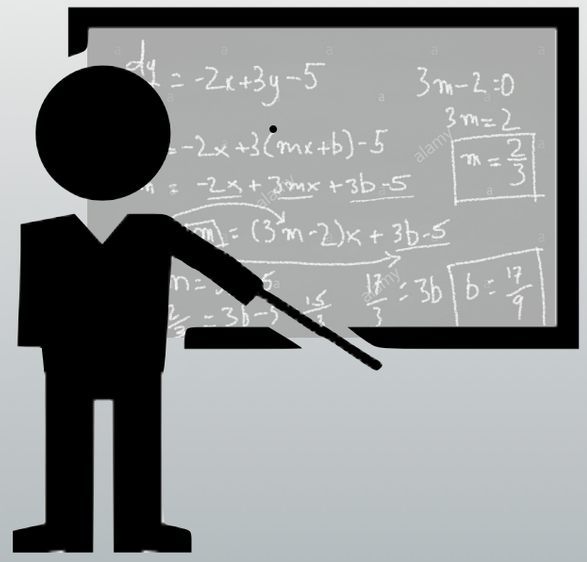
67% of college Grads Don't have jobs lined up yet (at least)

Door of Clubs survey mystudentvoice.com 2017

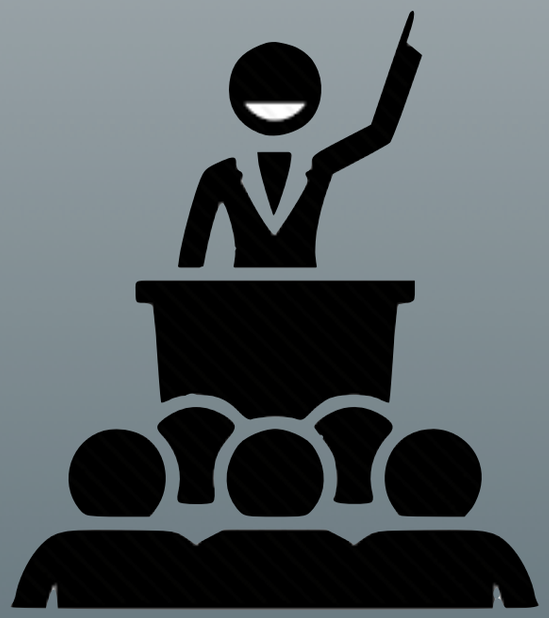
OUR NEEDS ARE CHANGING



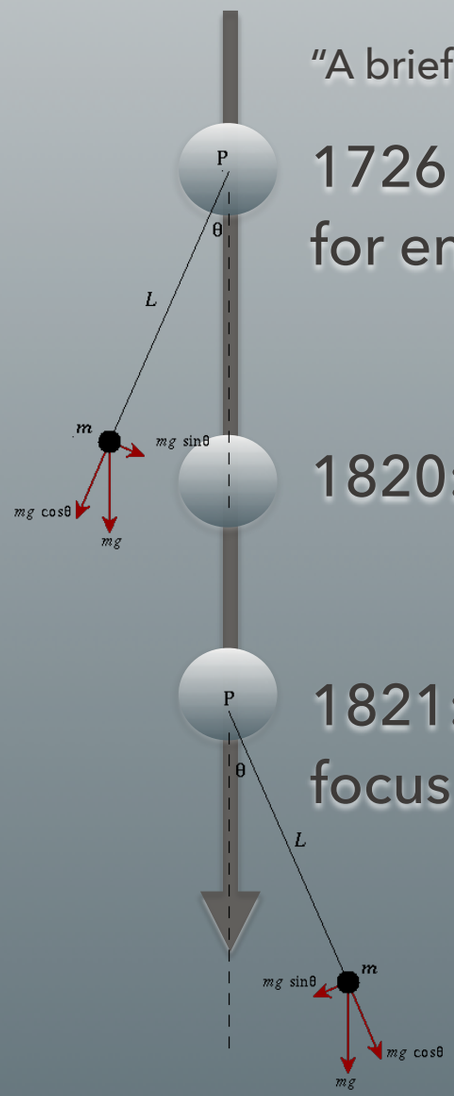
From the National Academy of Science, Engineering and Medicine, "Building America's Skilled Technical Workforce "(2017)



THE ROAD THAT HAS LED US HERE



STEP 1
LET'S UNDERSTAND THE HISTORY OF MATH EDUCATION IN AMERICA



An overly simplified timeline curtesy of

"Mathematics Curriculum Reform in the United States: A historical Perspective", G. Stanic & J. Kilpatrick

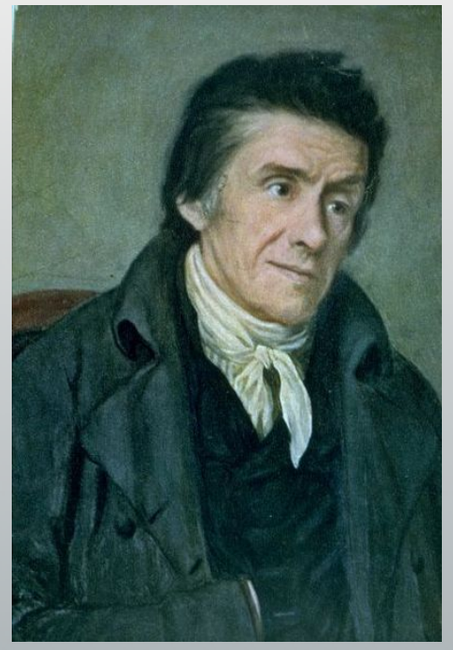
"A brief history of Mathematics in America", J. Furr

1726 Harvard hired it first math professor and made arithmetic a requisite for entry

note: secondary schools today still follow roughly the same teaching structure

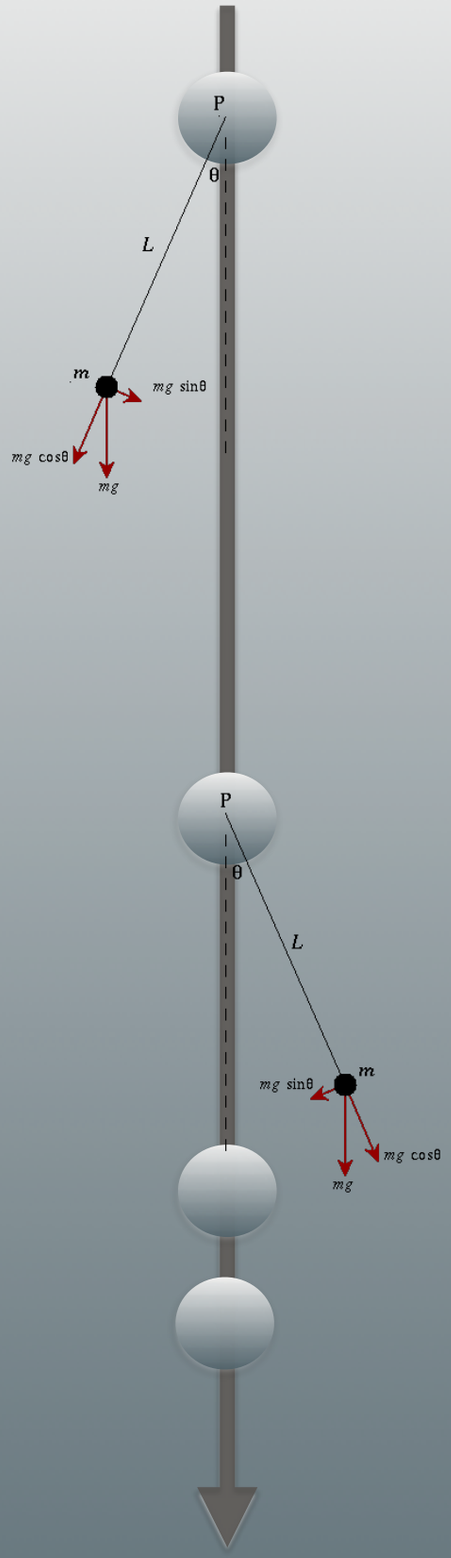
1820: Harvard introduces a requisite for algebra (1844 geometry)

1821: Warren Colburn's publishes "First Lessons on Arithmetic" - pushed focus away from memorization to problem solving



"The remaining history of mathematics education is, in part, an ongoing struggle for the realization of Pestalozzi's ideals of learning through understanding first"

J. Furr



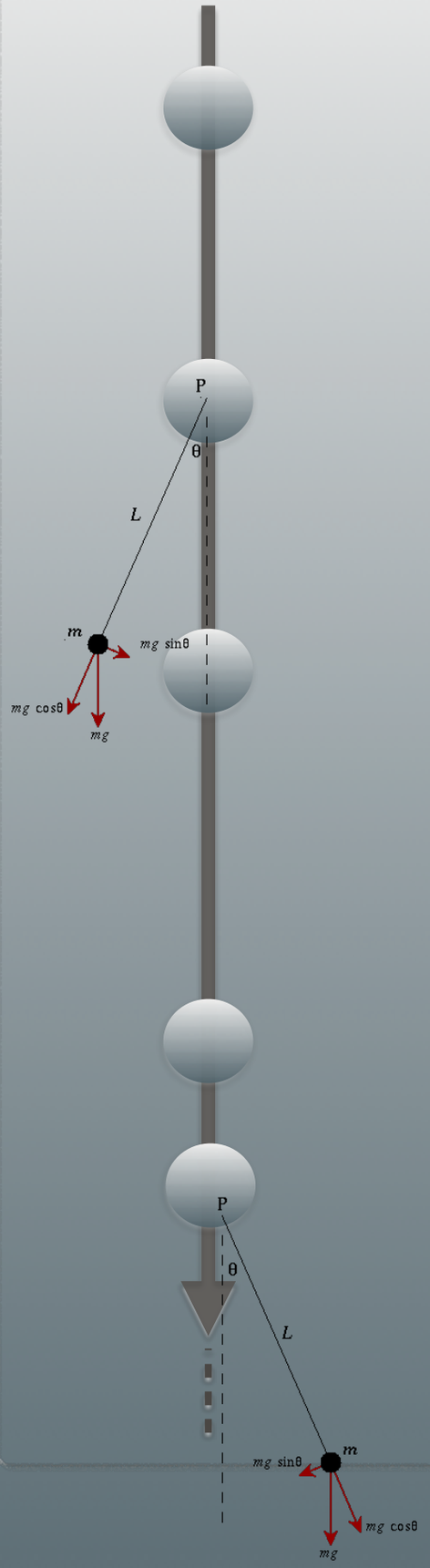
1845 Stitt, 1880 Hall: survey's re-assessed what kind of math was relevant to business and average citizens -> only the "basics"

Led to massive numbers of both public and privately funded "committees of experts"

1892 Committee of 10: Recommended a general trend towards the decompartmentalization of the subjects in mathematics, and parallel courses designed to integrate the subjects

1900 College Entrance Examination Board

1920 National Council of Teachers of Mathematics



1944-1945: US Government takes interest in mathematics: realize officers have inadequate analytical skills -> jeopardized national defense

1950s “New Math” movement: there was a rising awareness that the job market was requiring increased technical competence

1963 the “Cooperative Research Act” pushes for more structure vs memorization and more modern concepts

1960-1970 tests scores were at all time lows

1980s led to another movement to “regain excellence in math”…A nation at risk…No child left behind (1990s)…Race to the top (2010)

WHAT CAN WE LEARN HERE?

We have been struggling with the idea of education reform for well over 100 years

The pendulum has swung back repeatedly

Society realized the importance of analytical thinking, decompartmentalization, and more technically competent workers long ago…but it's not where our effort is going?!

THE UNINTENDED LESSONS STILL BEING TAUGHT IN HIGHER EDUCATION

Compartmentalization persists

Course grades represent perceived outbound value

Memorization still dominates against problem solving

We praise testing, often skip the examples, seldom make time for real word problems, and even question if the proofs still have a place in undergraduate education

The real problems get solved in academia

Industry just applies simplified academic theory

Industrial math means fitting lines to data

LET'S OWN SOME HARD TRUTHS

Academia often views itself as the elite

Most professors have had little or no first hand experience with industry

Academic institutions that are "industry friendly" are often times still quite difficult to work with

There is growing dogma in industry that more education actually makes things worse

Policymakers will not save us

MODERNIZING CURRICULUM

Is there low hanging fruit?

THE LARGEST USER BASE OF MATHEMATICS IS NOT PEOPLE ANYMORE

Connected devices now outnumber human beings on this planet - and by 2020 this ratio is predicted to be 6:1

Computers are a critical component of mathematics in todays world

LET'S ACCEPT IT, COMPUTERS ARE HERE TO STAY

Discrete systems, algorithms, and basic programming are therefore an extremely important component of education

STATISTICS, ERROR ANALYSIS, AND UNCERTAINTIES MATTER

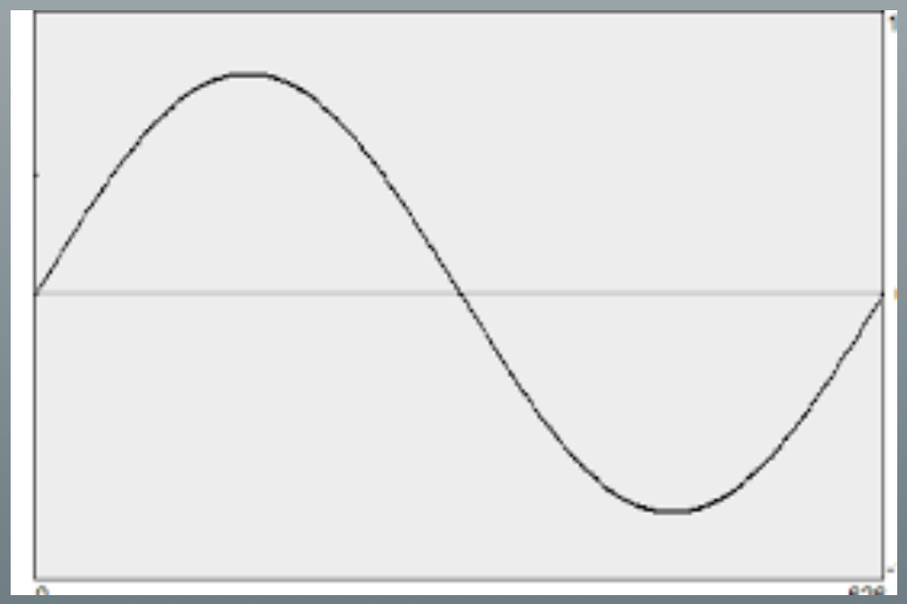
Errors and uncertainties must be recognized as being at least as important to understand as anything else in the current curriculum

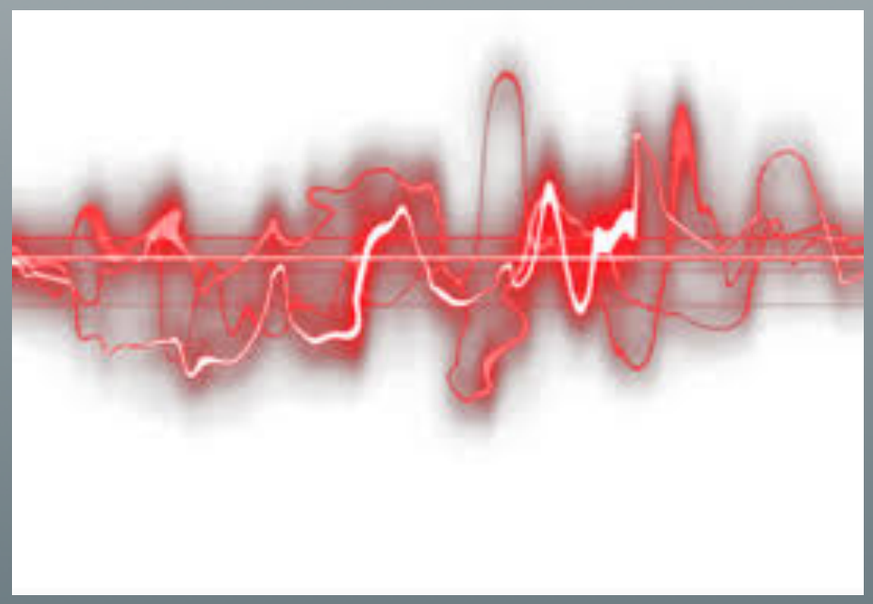
Statistics should be looked at a first class citizen

SIMPLIFICATION IS SIMPLER, YES …BUT AT WHAT COST?

There are rarely rigid boundaries in real life

Real world examples can solidify understanding





THE HARD PART OF THIS DISCUSSION

There is more to addressing this seemingly innocuous question of “what should we teach” than one might at first think

Fundamental ideas like “what is math?” and “how does it fit into the broader context of society?” are actually still not agreed on

THERE ARE MASSIVE IMPLICATIONS IN WHAT WE DO NEXT

- Social implications

We have to take an active effort to be involved beyond our small circles and begin closing the gaps between academia, industry, and policy makers

In many unintended ways we continue propagating dogma

- Philosophical implications

The biggest changes that appear to be required are less about the specific topics and more about our attitudes regarding what we are trying to accomplish and how willing we are to be involved

THINGS I HOPE YOU WILL TAKE AWAY FROM THIS

The easy stuff

We should integrate the computer and learning to properly use it much more deeply into all of our curriculum

A rigorous treatment of linear algebra, statistics and discrete systems would help

We should attempt to provide messier more real world problems into our teaching process

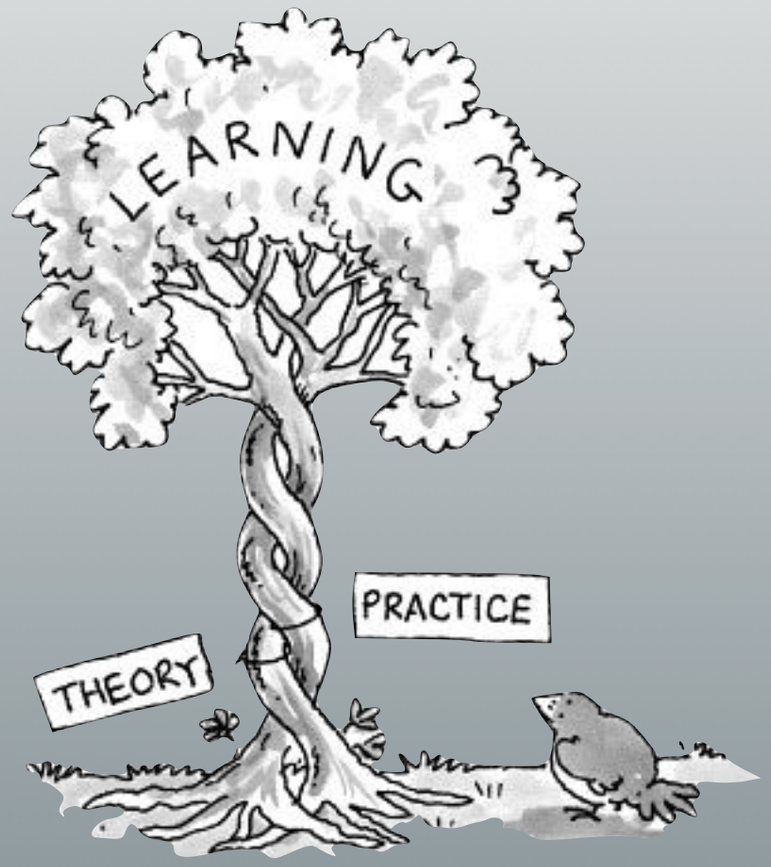
THINGS I HOPE YOU WILL TAKE AWAY FROM THIS

The harder stuff

We should all be forcing ourselves to get out of our own boxes and dedicate time to this

We should attempt to decompartmentalize subject matter

Learning to learn, to communicate, and to apply critical thinking are the most essential ingredients of any curriculum



Learning how to learn, to think analytically, and to communicate are the core value from academia that have allowed me to succeed

How mathematics is taught is often dependent on the teacher's or society belief about what mathematics is ... But only when a teacher believes that the real value of mathematics is in an ongoing process of discovering new relationships will he naturally guide pupils to learn through analytical induction

Grouws, 1992

THANK YOU