Earth and Atmospheric Science in a World of Rapid Changes to Academia and Labor Dynamics

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Headwinds

- Demographic and social challenges for departments
  - Enrollment cliff
  - Pandemic hangover
  - Evolving motivations for college degrees
  - Unforced errors in the case for college
- The nature of science work is changing
  - Occupational evolution
  - Skills-focused employment
  - Wholesale changes to industry structure
Employment in the Pandemic

- 88% of geoscience employers received government assistance.
- Effective geoscience unemployment rate was 4%.

![Monthly geoscience employment chart](image-url)
The Enrollment Cliff

External and Internal Factors

- Demographics of College-Age Students
  - Each generation requires a new higher ed business model
  - It’s hard to cut back….
- Complications from the Pandemic
- Obvious Pathways to Employment
- The Loan Forgiveness Marketing Debacle

There will be winners and losers
The Curse of Demographics
US Population Change from 2010-2019 by Age

Hundreds of thousands of people

- Be Afraid, Very Afraid

- Millennials

- Gen X

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Demographics Drive University Business Models

• Gen X remembers the mass budget cuts and losses in education
• The Millennial years fueled a binge
  • Debt loading
  • Focus on “experience” and broadening of education’s role
  • Big budgets, big overhead, and…. It was a different time
• More than 25 years ahead of at best no-growth
Diversity, We can’t “Don’t Look Up”

Racial Demographic Trends in College Enrollment

Education Data Initiative source: National Center for Education Data Statistics

*A multiracial category did not appear until 2010

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Workforce Participation by Occupation
All Underrepresented Populations

In 1972, underrepresented populations was 2% of the geoscience workforce.

1972-2016, really was negligible progress

Credit: AGI, data derived from the U.S. Census Bureau and U.S. Bureau of Labor Statistics
Workforce Participation by Occupation
Black and African-American

Credit: AGI, data derived from the U.S. Census Bureau and U.S. Bureau of Labor Statistics
How do we go from 18% to 2% in 1 year?

Pandemic had an outsized impact, but we failed to support our in-progress undergraduates.
How do we create real change?

We need to change the culture of the geosciences. Change will not come from simply “intervening” with underrepresented populations.
Did the Pandemic Change Everything?
Student Culture has Abruptly Changed
Comments for COVID-19 Study and the News

“The reading, writing, arithmetic, all the discipline skills, the book skills were all there, but putting those to good use and the things that they don't teach you in college that you need to know when you get in the real world, we're missing.” – department head

“They have extraordinarily poor social skills right now. And I think that can be seen at all levels of the institution. And I'm not just talking about students. I'm talking about staff and coworkers. It's everybody, right? We need to learn how to talk again to others … especially in large groups, because when you're in large groups, you're working off of other people's facial cues of when to stop and went to go. And when cameras are off, you don't have those social cues to work with.” – geoscience faculty

The New York Times

At N.Y.U., Students Were Failing Organic Chemistry. Who Was to Blame?

Maitland Jones Jr., a respected professor, defended his standards. But students started a petition, and the university dismissed him.
Motivations for Higher Ed Reflect Economics
Changes in occupational status, Feb 2020 - Mar 2022
Recent geoscience graduates, Classes of 2014-2021

- Initial population
- Most recent population
- Transitions between statuses

- Unemployed
- Retired
- Non-academic professional
- Student
- Post-doc
- Academic faculty
- K-12 faculty
Career trajectories

Growth in post-doc and non-academic professions.

Some increase in unemployed graduates.
An Unforced Fumble in Valuing College
Bad Marketing with Loan Forgiveness

- Loan forgiveness signals higher education is not worthwhile – requiring a federal bailout to “customers”
  - Terrible way to attract first-gen students
- Did nothing to address the cost of attending college
- Coupled with high inflation and interest rates
  - Less cash for tuition
  - Potentially more difficult loan terms in the future
  - Easy loans fueled higher ed inflation
The Nature of Science Work is Changing
Solution Pathways to Strong Enrollment
Rise of Machine Learning in Geoscience

\[ D = \text{Total Labor Demand (FTE)} \]
\[ X = \text{Economic Activity Per Person} \]
\[ n = \text{Total Workers} \]
\[ X' = \text{New Economic Activity Per Person} \]

If \( X' = 5X \), then \( n \) drops substantially, while \( D \) remains the same.
Mining Industry and Machine Learning

- Mining companies determined 80-82% of their geoscientists time was in searching, cleaning, and prepping data
- Energy Companies reported 79% in data effort
- GoldCorp collaborated with IBM to develop Watson for Natural Resources
Is Machine Learning Effective in Geoscience?

- Contrived problems had a 35x decrease in solution time using Watson than a senior geoscientist team.
- First real-world problem:
  - Senior geoscientist team: 1080 person-hours to solve the problem.
    - Nearly all of the time was in data management and processing.
  - Watson for Natural Resources: 14 minutes.
Is Machine Learning a Threat?

• Only if we do not evolve!

• Traditional occupations are disappearing (loggers, interpreters, etc)
• Move towards the “augmented geoscientist” – who focuses on domain problem solving with robust tools at their disposal.
COVID-Era Graduates Skills Reflection
Skills Wished had Gained

- Project management: 20% respondents
- Programming skills: 50% respondents
- Database management: 50% respondents
- Field skills: 40% respondents
- Lab skills: 40% respondents
- Data visualization and mapping software: 60% respondents
- Machine learning, AI, data science: 40% respondents
- Proficiency with virtual platforms: 10% respondents

Respondents
What is the “today” skill portfolio?

- Core geoscience understandings
- Core scientific understandings in physics, chemistry, biology
- Ability to work quantitatively
- Licensure keeps ALL doors open
- Think of co-curricular skills or requirements:
  - HAZWOPER certification
  - FAA Drone Pilots License
  - Python/R programming
  - GIS/visualization
Geoscience Goes Gig-lite

Upstream (Oil, Gas, Minerals, Water)

Geo Jobs Growth

Downstream

Major Companies

Geo Jobs Growth

Smaller Firms
Other Apparent Factors

- AI/ML greatly reducing middle-skill geo jobs
  - Seismic/Strat Interpreters
  - Loggers
- Spread of fixed-price contracts
  - Shifting risk to smaller firms
  - Demanding higher skills/agility for increasing margin
- Increase in the singleton geoscientist
- Geosciences need to become solution providers
  - Skillfulness and innovative thinking are winning traits
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