CHAPTER 2 – COMING AND GOING: WHAT'S HAPPENING TO THE YOUNGEST AND OLDEST COHORTS IN THE STEM FIELDS

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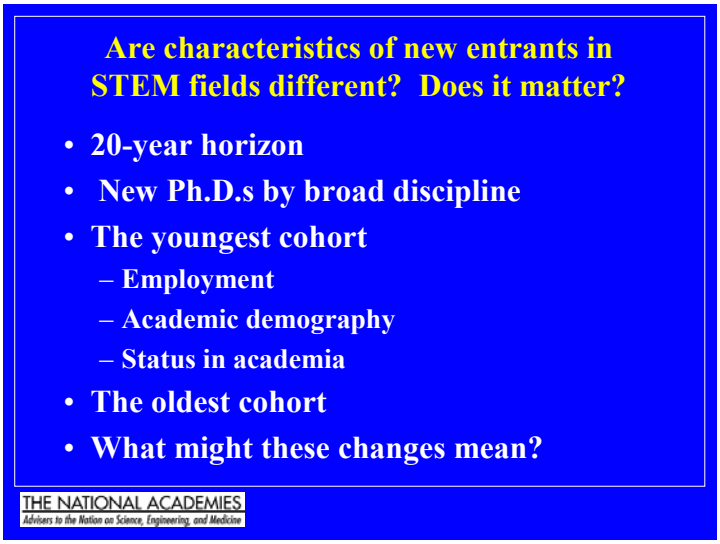
This presentation will examine what is happening to the youngest and the oldest cohorts in the science, technology, engineering and mathematics (STEM) fields. It uses National Science Foundation (NSF) data from the *Survey of Earned Doctorates* (SED) and the *Survey of Doctorate Recipients* (SDR). We have not yet examined data from the Bureau of Labor Statistics' *Current Population Survey* (CPS).



What we are going to do is look at a 20-year horizon, because year-to-year things seem to change very slowly. But, over a 20-year horizon there are some definite changes. First, we are going to look at new PhDs by broad discipline, and then we will delve into the youngest cohort, using SDR data. By young, I mean individuals who received their PhD sometime between within ten years before a particular date. These are young people, although as will be evident, younger PhDs are becoming older chronologically. We will look at employment—at the demography of the academic workforce and at the status of this youngest cohort in academia.

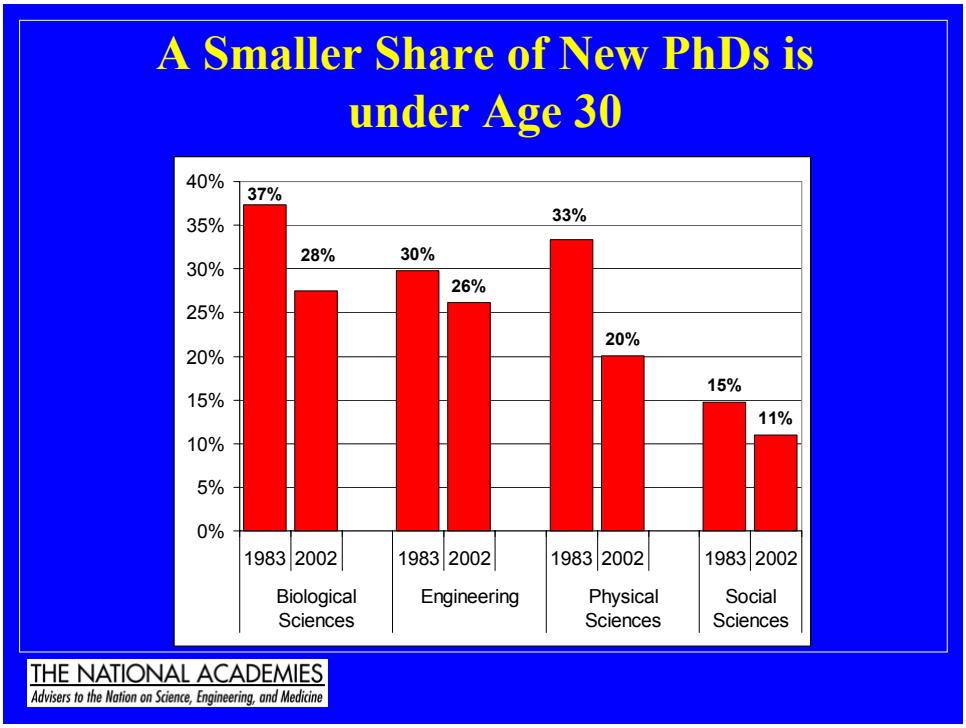
We will also look at the oldest cohort. The oldest cohort is interesting for many reasons, among others, that some of us are now entering it, but also because these are the people who retire. Due to the elimination of mandatory retirement, they are no longer forced to retire from academia. Their retirement behavior, in a strict demographic model, would open slots. But, the question is, is this actually happening? Furthermore, the cohort is small—the majority of faculty who were hired in the 1960s and 1970s are now entering a period during which they will experience higher retirement rates. It will be interesting to note if they have the same retirement behavior as academics in the past.

Finally, we want to ask ourselves what these changes might mean.

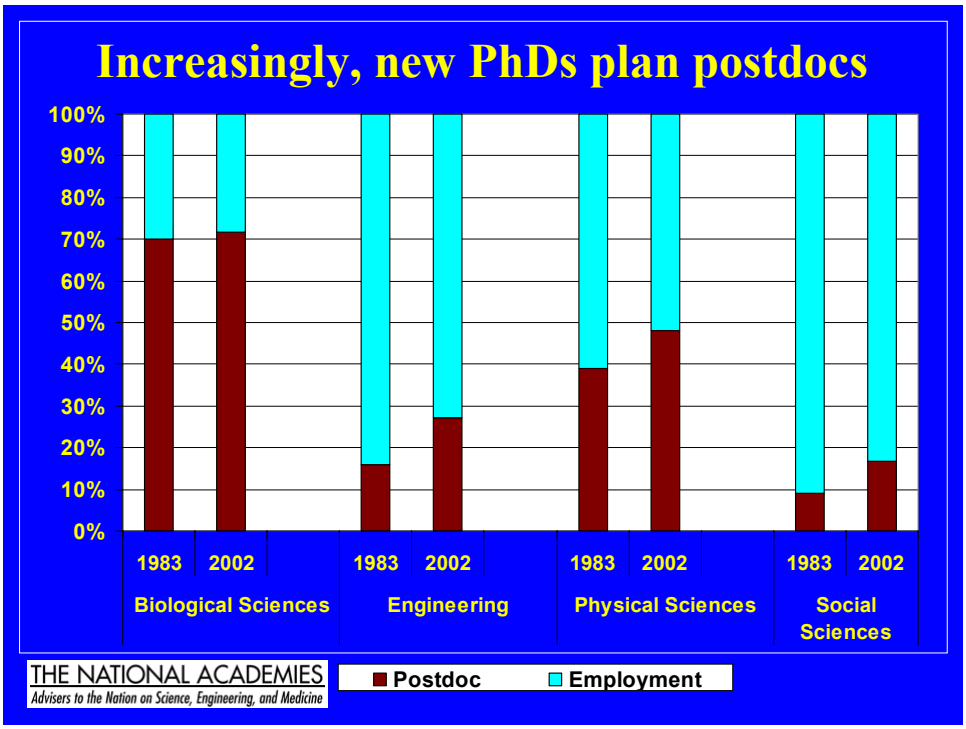
All of the slides in this presentation will look at the broad fields of biological sciences, engineering, physical sciences, and social sciences. Mathematical and computer sciences are included in the physical sciences.

Let's start with new PhDs and with people under the age of 30. The chart on the following page looks at the share of new PhDs under the age of 30 in 1983 and 2002. I could have given you a line chart, but this type of chart gives you the bigger 20-year picture. The smaller share of new PhDs under the age of 30 in every field is striking. It is interesting to note that the fields that 20 years ago had the largest percent of people under 30 have had the biggest drop. Those two fields—the biological sciences and the physical sciences—are the fields where there is at least an urban legend that your best work gets done while you are young. Something is happening to make PhDs older.

The chart includes U.S. and non-U.S. citizens receiving PhDs from U.S. institutions. Non-U.S. citizens typically finish their degrees in as short a time as possible, but the time to degree has lengthened for everyone during that 20-year period.



The next chart shows new PhD plans for going into postdoctoral study in 1983 and 2002. The reddish-brown bars on the bottom are the percent going into postdocs and the blue bars on top are the percent of new PhDs who plan to go directly into employment. When people receive their PhDs they are asked on the *Survey of Earned Doctorates* what their immediate plans are, and this is how they answered. This graph includes those with any plans, not just those with definite plans.

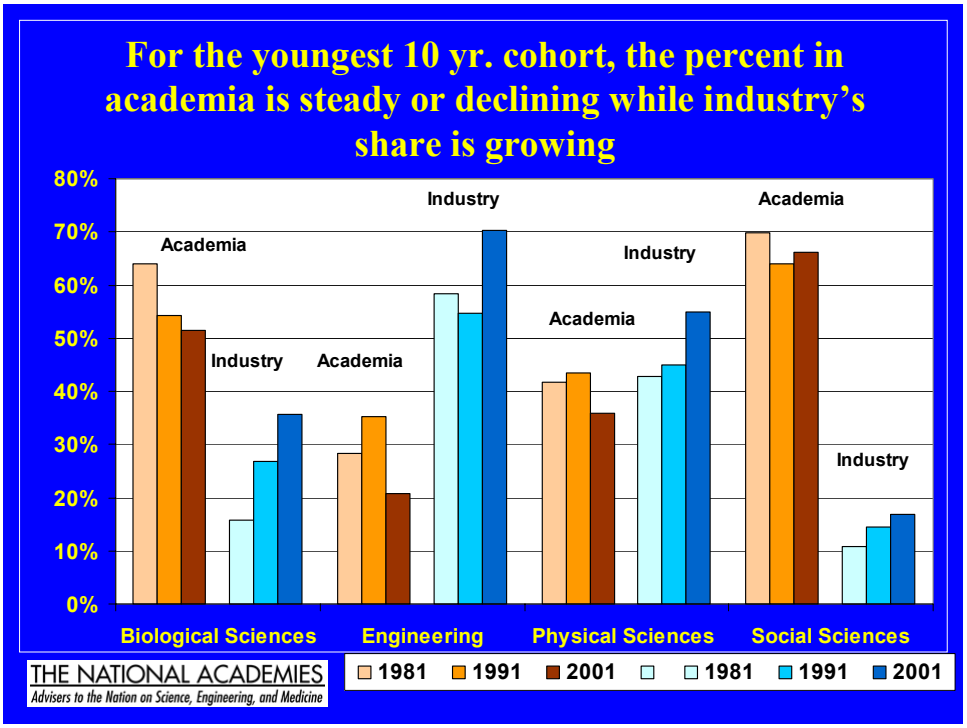


The biological sciences are of course the postdoc king, but it is interesting to note that they have as high a percent going into postdocs as they are going to get. That is sort of the ceiling or saturation level. What is more interesting is that in engineering, the physical sciences and the social sciences, a growing share of new PhDs are going into postdocs. Although people these days say that the postdoc issue is biology's problem, it may become more widespread five or ten years from now.

Let's talk about the numbers in these fields. In the biological sciences, numbers of PhDs have been growing, and so if the data were presented as raw numbers, we would see a higher bar for 2002 although the share is constant.

Now let's go to the SDR data and look at the youngest ten-year cohorts in 1981, 1991 and 2001. Note that in 1991 there was an influx of Chinese graduate students, so 1981 and 2001 should be viewed as the trend indicator years.

The first set of bars in "October" colors in the chart to the right show academia—the earliest year within those bars is the lightest color and the most recent year is the darkest. Industry is shown in the blue bars—the second set of bars shown for each discipline. You can see that a declining percent of the youngest cohort has been going into academia and an increasing percent has been going into industry.

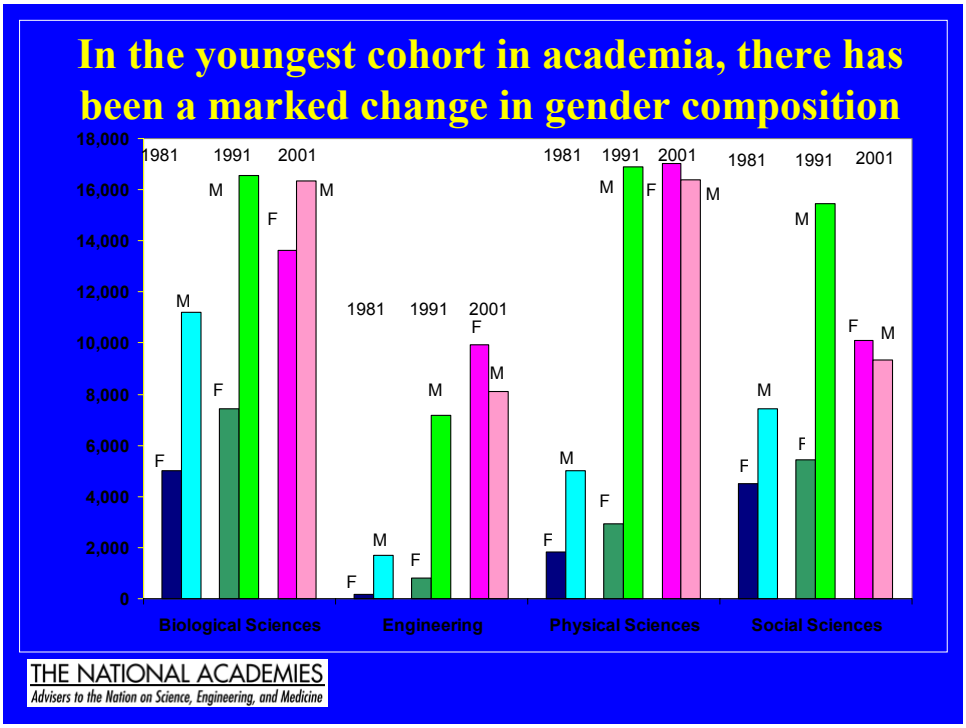


Government and other nonprofits have not been included in this chart, but it is quite clear that industry is taking an increasing share of the youngest cohort. In engineering, industry has always taken a large share, but even that share is still growing. A big jump is also seen in the physical sciences in 2001. The increase is less in the social sciences, but again, that is to be expected. It is not clear whether it is demand-push or supply-choice, but a declining share of the youngest cohort is choosing academia.

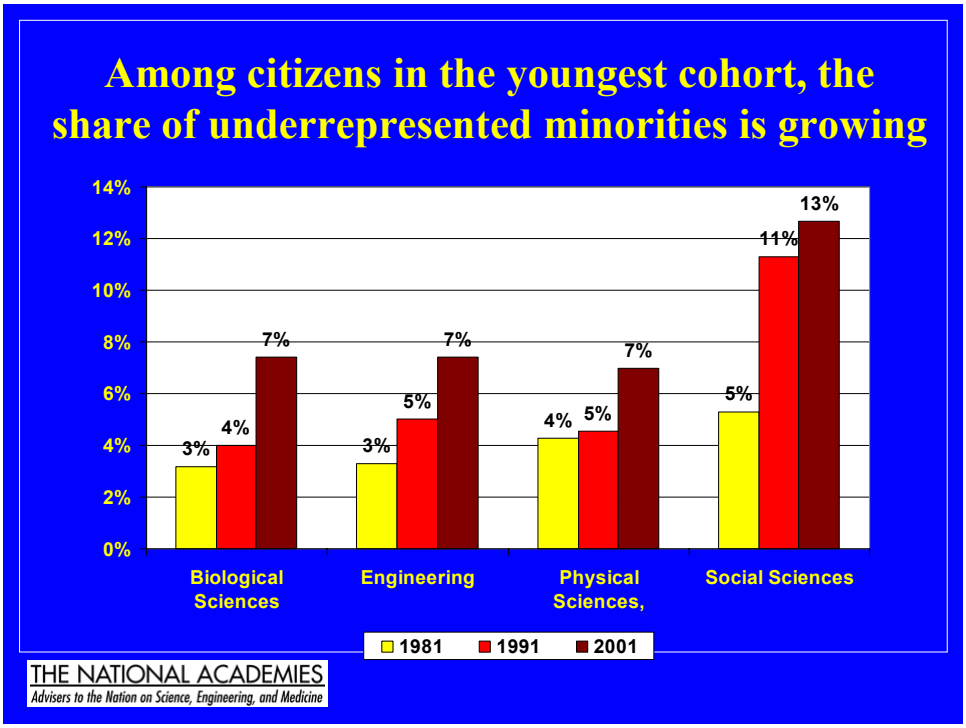
Although a declining share of this youngest cohort is going into academia, there has been a marked change in gender composition within this cohort. The chart on the following page shows the numbers of men and women in academia by broad fields in 1981, 1991 and 2001. The bar on the far left shows women in the biological sciences in 1981 and the bar to the right of it shows men in the biological sciences in 1981. The next two show men and women in 1991, and so on. Once again, this youngest cohort includes those who received their PhDs one to ten years before the date of the survey.

In 1981 and 1991, in almost all of the fields, considerably more men than women were being hired into academic positions. What happened in 2001 is that in some of these fields, the share of the youngest cohort going into academia has gone down, but the numbers of women going into academia are actually increasing. For example, if you look at the 2001 bars in the physical sciences, social sciences and engineering in the chart, the numbers of women in this youngest cohort in academia exceed the numbers

of men. These are preliminary findings which need to be verified, but if this is really true, it is very interesting.



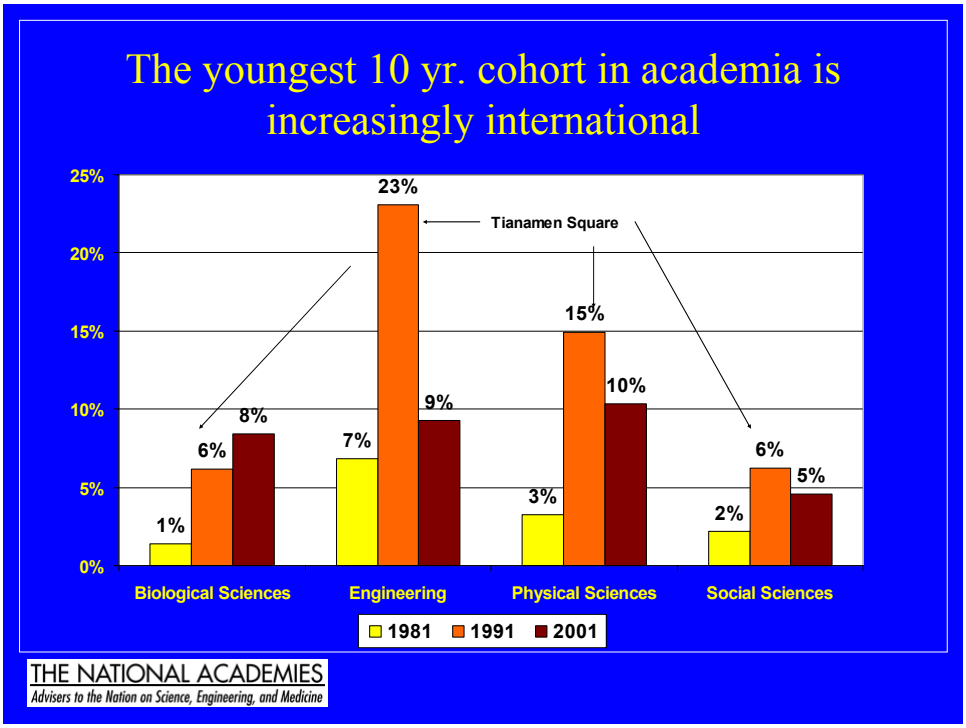
Among citizens in the youngest PhD cohort in academia, we finally see a growth in the percent of underrepresented minorities, and we see it across the board, as shown in the next chart. This is probably a pipeline result, given that institutions have been working for a long time to increase the minority share of PhDs. This is a front on which we have seen very little progress.



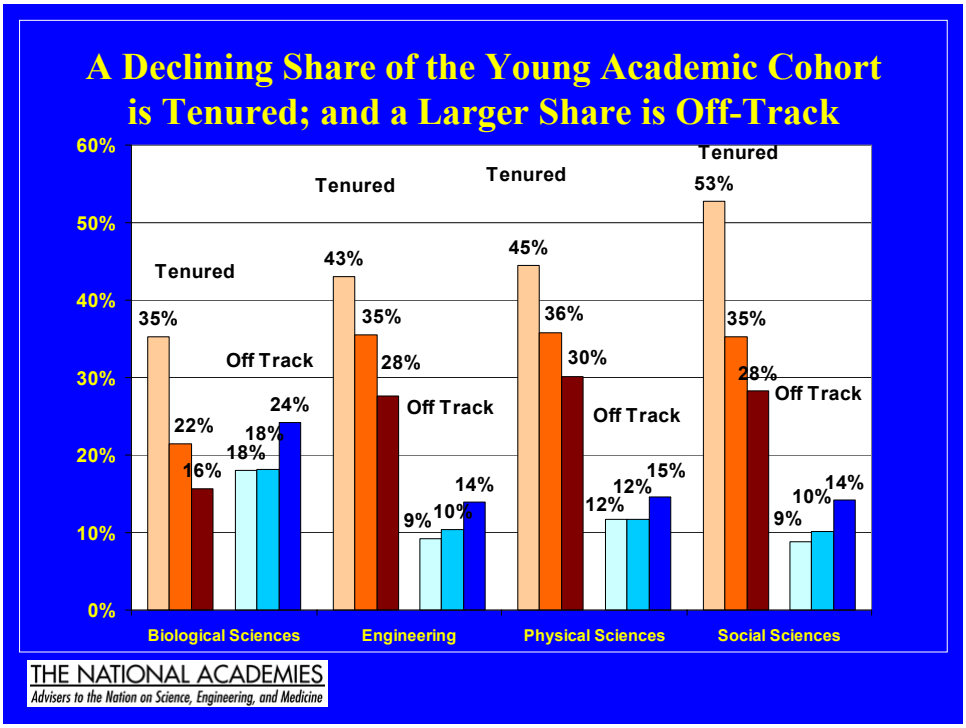
Remember that the seven percent figures for biological sciences, engineering and physical sciences in 2001 are a percent of a declining number going into academia. However, a larger share of that number is made up of underrepresented minorities.

This youngest 10-year cohort in academia is increasingly international, as seen in the chart on the following page. There was a spike in 1991, but that happened due to the influx and retention of Chinese graduate students mentioned earlier. But, if you look at just 1981 and 2001, the trend is unmistakable. What you see is simply a growing proportion of the academically employed PhDs who are international. This is an understatement because these data—from the *Survey of Doctorate Recipients*—do not include PhDs who got their degrees from non-U.S.

institutions. For example, the 8 percent figure for biological sciences in 2001 would be much higher if this chart included individuals who came to the U.S. as postdocs and then got regular positions in academia.



Postdocs are not being included in these data because I am really interested in the teaching workforce. Jim Voytuk from the National Academies was kind enough to prepare the tables from which I prepared these charts, and when I looked at the tables, I thought something was wrong. What was wrong was that postdocs were included in the data, which resulted in a much higher international percentage. Whether to include postdocs or not is a question whose answer depends on the purpose of the data. If you are looking for the research workforce, include postdocs, but if you are looking at the teaching workforce and the faculty workforce, do not. The data do include all faculty who are tenured, non-tenured, tenure track, and not on the tenure track, as well as other academics including some academic staff.



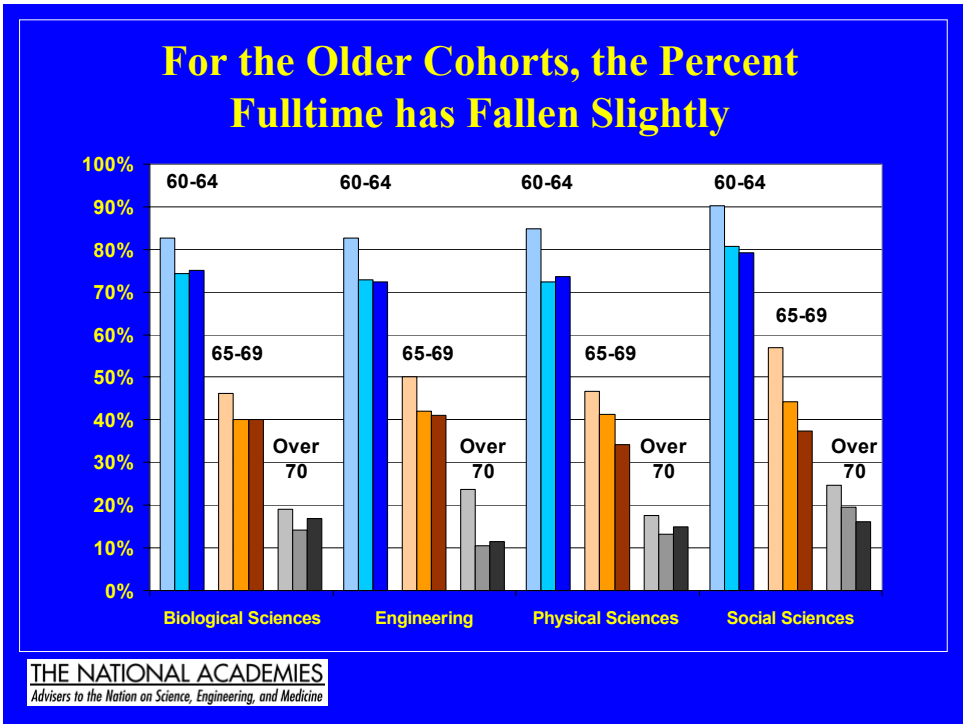
The chart to the right looks at what percent of the youngest cohort are tenured and what percent are in off-track positions in 1981, 1991 and 2001, once again broken out by broad field (biological sciences, engineering, physical sciences and social sciences). Untenured tenure track positions

are not included on the chart, which is why none of the numbers go much above 50 percent. Also left out are "other staff."

What you see for this youngest cohort is that an impressively declining proportion of the youngest cohort has been awarded tenure recently. We could go further to look at the 20-year cohort, to see if that still is the case—to see if tenure is being delayed or if a larger proportion is really not ever getting tenure. What you also see is an increase in 2001 in the percent of faculty who are off-track, i.e. those who do not have tenure track positions. Over time, there has been an increase in the proportion of the youngest cohort in off-track jobs.

Thinking about demand-pull and supply-pushes, if a new PhD is forecasting a career in academia from 2001 data, the chances of tenure seem much lower than in the past. That may actually feed back to the choice of academic jobs by PhDs, and may partially explain the decline in those choosing academic careers.

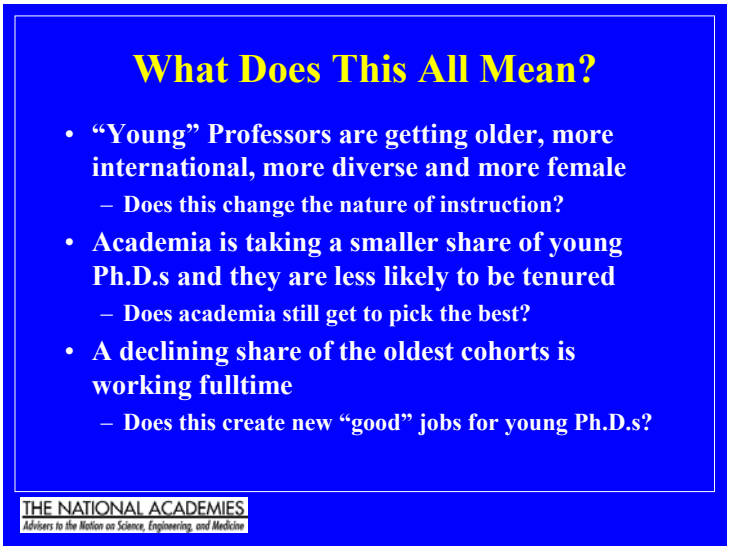
Now let us consider older people. The question is: what are they doing? In particular, the best question may not be whether they are choosing retirement, since many academics may not want to completely leave their life's work. You do not see a lot of academics on the golf course. The other problem is statistical. Looking over this 20-year period, there was a time in the mid 1990s when NSF added a lot more older people to the over-70 cohort so that they could find out about their behavior. Anyhow, there are more people, but the question is, would that have had an effect on their propensities or did the larger sample behave the same way as the smaller and less reliable sample?



The chart to the right, which looks at 1981, 1991 and 2001, divides the older PhD cohort in academia into three groups, the young old (ages 60-64), the medium old (ages 65-69) and the older old (over 70). What we see consistently—which suggests that something economic may be going on—is a decline for all these cohorts in the percent who say that they are employed full-time. As age increases, the percent full-time gets smaller and smaller, so more people are retiring or going to part-time work between the ages of 60 and 64, and 65 and 69, and finally when they are over 70.

It is interesting to note that from 1991 to 2001, the percent of the over 70 cohort employed full-time increased slightly in every field except for the social sciences.

From 1991 on this is a post age discrimination act world, and so the people who are still full-time over 70 are choosing to not being required to retire. Given the demographics of the academic workforce, there are not that many people who are subject to this choice yet, but it is mildly reassuring to know that in an unconstrained environment, only about 10 to 16 percent of those are still working full-time. So although non-retirement tends to be a problem, especially at the research universities where some people cannot imagine ever doing anything else, it does not seem to be a problem overall. Older people in the academic scientific workforce do leave full-time work.



So what does this all mean? First, the "young" are getting older—young professors are older now. The composition of the academic workforce and the science and engineering workforce was different 20 years ago than it is now. Why is that? Part of the culprit is longer time to degree, but there are a number of reasons why people are getting PhDs later. One reason could be the "conspiracy theory" that once aspiring PhDs get really good in the lab, senior scientists would try hard to keep them. Since the young scientists do not see a whole lot of jobs out there, they would just as soon stay, so they are willing collaborators in the extension of time to degree. But whatever the cause, younger professors are older. They are also more international, more diverse and more female. Does this change the nature of instruction? This question is important because our undergraduate student body is also more diverse and more female than it was 20 years ago, and the professoriate is not changing as rapidly as they are.

Academia is taking a smaller share of young PhDs, and young PhDs are less likely to be tenured. Does that make academia a less attractive place? Is it still true that academia gets its pick of the best? And how do you know who the best are? There might be some sort of selection effect when it is more risky to take on an academic career than it was a number of years ago.

Finally, a declining share of the oldest cohorts is working full-time. For demographers, that looks like a good thing, but does the fact that the older people are leaving full-time jobs actually create openings for younger people, especially in a fiscally-stressed environment? That is not clear at all. Even though people seem to be leaving full time employment earlier, it is not clear that is creating openings for younger people.

Audience Comments/Questions:

- Sam Rankin, American Mathematical Society – Did any of your questions address job satisfaction and measure of time to degree versus how satisfied they were with their job after?

  Response – No, but that would be an interesting thing to look at.

- Alan Rapoport, National Science Foundation – Just a little preview about something I will say this afternoon, because Charlotte and I are talking about some of the same issues. I defined my cohorts a little differently – three years out, 4 to 7 years, and 7 or more years out from PhD. One interesting thing I found is that those who are just within 3 years are actually much more likely to go into academe than the 4 to 7 or the overall cohort. Though they have declined over time also, the decline has been relatively minuscule. For the youngest ones, it is about 50/50 whether they go into academia or not, and it is in the low 40s for the rest of them. I just thought that was interesting.

  Response – Actually, that is interesting because that growth in industry jobs might actually be people who have had their fun in academia and they are now getting a "real" job.

- Roberta Spalter-Roth, American Sociological Association – When people retire, is that disciplinary death? And when you have a lot of retirees does that mean you are losing a whole lot? ASA has been looking at things like are people going to meetings? Are people buying journals? It does look like until 75 (and we can track them after 75) people are potentially active in the discipline even though they may call themselves emeritus, which they may do because it is cheaper to join that way. We might also want to start looking at a few additional measures of what retirement means.

  Response – I think retirement means different things in different fields. If you are in an equipment-intensive occupation, maybe as you get older you move to more theoretical activities so you do not have to have all of the equipment. But, it would be interesting to distinguish among the STEM (science, technology, engineering and mathematics) fields in that regard.

- Joan Aron, Science Communication Studies – One of the issues with retirements from full-time positions generating new positions, is that there has been this huge growth in "gypsy teachers" and contingent workers. How does that fit into those statistics?

  Response – If they are working full-time it fits into that off-track faculty group. I did not really look at full-time and part-time yet because I know there has been an increase in men working part-time and women have stayed about the same. But I think the way it fits in is that they are in that off-track segment. Again, this is more of a phenomenon in the humanities, some of the social sciences, and in mathematics somewhat, and less of a phenomenon in the physical sciences, engineering and the biological sciences.

- Jill Karsten, American Geophysical Union – Are community college data included in this, and are there any trends related to that subset that may be torquing some of these data?

  Response – Community college data are included. I did not think that any trends related to that subset could be torquing the data, but I did not ask. To begin with, a smaller share of community college faculty are PhDs—they use a lot of adjuncts. I do not know whether that would have an effect, but probably not much.

- Sam Rankin, American Mathematical Society – Do you see the trend of more PhDs going in industry as bad? In mathematics, I actually think it is a better thing because for 20 years or so you could almost predict, if you looked at a new PhD crop, that 80 percent are going to go to academia and 20 percent are going to go to industry or government. Now that has moved up only slightly to 70/30. I believe if we got closer to 50/50, the discipline would actually be in better shape. In other disciplines like chemistry it might be 50/50 already or maybe even more go to industry than into academia. So I just wondered whether you see it as a bad trend or as a good trend.

Response – I do not really know. I would be interested in hearing you all talk about it, and again, this is demand/push, supply/pull. I have worked in industry and I think there are fascinating problems. It is a great place to be research friendly and have real data right there to work on, and real problems that might have an effect on if you are successful in doing your research. So I think it is just another track. The problem is that we are educating people in one of the tracks, and that is what the people who are educating them know. The question is, how are they going to find out about how interesting it might be to be a mathematician, say, in industry.

- Adam Fagen, the National Academies – I am looking at your slide about the gender composition of the youngest cohort, and for 2001 it looks like there are more women than men in each of the academic positions, except in the biological sciences, where there is probably the highest percentage of women getting PhDs. I am wondering if you have any idea what is going on?

  Response - I do not, and all I would speculate on is anecdotal. It is very difficult to be a woman in the biological sciences and go into an academic job these days, because you get your PhD after 5 years. Then you spend another 5 years or so in a postdoc. And then you have to get your first grant and establish yourself as a biological scientist. That particular career path is not particularly family friendly, and for women who might want to do something like have children, it is not at all clear how they manage. I gave a talk to a group of postdocs at Penn a couple of years ago, and all they wanted to talk about was how they could have a career and have a family, which was actually not what I had expected. So working in an industrial lab may just be an easier way to do multiple things. But I am just speculating about that.

- Lynda Carlson, National Science Foundation – When you say industry, does that include nonprofit?

  Response – No, that is part of the “other” that is not there.