Technology Anxiety
Past and Present

David Autor, MIT and NBER
MIT 6.141 Guest Lecture
May 8, 2013
1. **The case for concern**

2. A brief history of technology anxiety

3. Not enough jobs versus the ‘wrong’ jobs

4. What should the Luddites have worried about?

5. Why *you* should care if *other* people go to college
Declining U.S. Labor Force Participation Since 2000

Employment-Population Ratio - Men (LNS12300001)
Employment-Population Ratio - Women (LNS12300002)

Shaded areas indicate US recessions.
2013 research.stlouisfed.org

Labor’s Share of Income

Labor income as a share of total income

NIPA data
BLS data


Jacobson and Occhino, 2012
An Era of Technology Anxiety

Erik Brynjolfsson
Andrew McAfee

Race Against The Machine

How the Digital Revolution is Accelerating Innovation, Driving Productivity, and Irreversibly Transforming Employment and the Economy
The Conscience of a Liberal

PAUL KRUGMAN

December 8, 2012, 8:37 am | ▼ 401 Comments

Rise of the Robots
Are We Entering the “PC Era” of Workplace Robotics?

Rodney Brooks with “Baxter”
Are We Entering the “PC Era of Workplace Robotics”?

**Baxter Robot**
Includes two 7 DOF arms with torso and head, integrated vision system, integrated robot control system, integrated safety system. Also includes one-year subscription to software capability upgrades and a one-year (2100 hour) warranty.

**Capability Upgrade Subscription and Extended Warranty:**

- No extended warranty
- One year or 2100 hours of robot use *(extending coverage to a total of 2 years/4200 hours)* - add $3,000
- Two years or 4200 hours of robot use *(extending coverage to a total of 3 years/6300 hours)* - add $5,000

**Price:** $22,000
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An Earlier Era of Technology Anxiety

Ned Ludd

“Machine Trashing”
1812 – 1813
1. **Technological change is a win-win**
   
   • The only free lunch that economists can believe in (Mokyr, 1990)

2. **Labor demand is unlimited**

   • “One of the best-known fallacies in economics is the notion that there is a fixed amount of work to be done—a lump of labor—which can be shared out in different ways to create fewer or more jobs.”

3. **Those who fear technological change are “Luddites”**
The sources of incomes changed, too. In 1901, the average U.S. family received 90.5 percent of its income from the earnings of family members, with 9.5 percent of these earnings contributed by children. By the 21st century, only 80.7 percent of family income came from the direct earnings of family members. Interestingly, in 2002-03 in New York City and Boston, family earnings constituted a greater proportion of household income than they did in the country as a whole. In New York City, family members' earnings contributed 85.0 percent to total household income; in Boston, family earnings contributed 89.0 percent.

During the 100-year period, household expenditure patterns also demonstrated great variability. In 1901, the average U.S. household had $769 in expenditures. By 2002–03, these expenditures had increased 53-fold, to $40,748. Over the same period, expenditures in New York City had increased 62-fold, from $814 to $50,319, while in Boston, the increase was 48-fold, from $880 to $41,814. (See chart 39.)

In real dollars, calculated with 1901 as the base, expenditures also demonstrated a notable increase. In 1901, as noted, the average U.S. family had $769 in expenditures. By 2002–03, that family's expenditures would have risen to $1,848, a 2.4-fold increase. In New York City the increase would have been 2.8-fold, from $814 to $2,283; in Boston the increase would have been 2.2-fold, from $880 to $1,897. (See chart 40.)

The material well-being of families in the United States improved dramatically, as demonstrated by the change over time in the percentage of expenditures allocated for food, clothing, and housing. In 1901, the average U.S. family devoted 79.8 percent of its spending to these necessities, while families in New York City spent 80.3 percent, and families in Boston allocated 86.0 percent. By 2002–03, allocations on necessities had been reduced substantially, for U.S. families to 50.1 percent of spending, for New York City families to 56.7 percent, and for Boston families to 53.8 percent. (See chart 41.)

The continued and significant decline over the century in the share of expenditures allocated for food also reflected improved living standards. In 1901, U.S. households allotted 42.5 percent of their expenditures for food; by 2002–03, food's share of spending had dropped to just 13.2 percent. For New York City households, the expenditure share had declined from 43.7 percent to 13.9 percent; for Boston households, the decline was from 41.7 percent to 13.5 percent. (See chart 42.)

Beginning in the 1970s, another trend emerged in spending for food. At the time, the average U.S. family allocated 72.4 percent of food expenditures for food eaten at home and 26.4 percent for food eaten away from home. In New York City, a similar pattern held: households allocated 72.2 percent of their food spending for food eaten at home and 26.7 percent for food eaten away from home.
Over the Course of a Century…
Share of Income Spent on Necessities Falls from 85% to 55%

Chart 41. Food, clothing, and housing expenditure shares for the United States, New York City, and Boston

Not One but Two Technological Revolutions: The Green Revolution and the Industrial Revolution

Agriculture Industry Services

U.S. Employment Shares in Agriculture, Industry and Services, 1840 - 2010

1840 1900 1950 2010

Johnston 2012
Automation of ‘Routine Tasks:’ Jacquard Loom (1801)

Two Centuries of Productivity Growth in Computing: 2+ Trillion Fold Decline in Cost of Computing v. Labor

Figure 2. The cost of computer power for different technologies

Nordhaus 2007
Information Technology Accounted for ~40% of Business Investment as of 2010

Information Processing Equipment + Software Share of All Private Non-Residential Investment, 1959 - 2010 (Source: BEA NIPA)
## Substitution, Complementarity: Tasks and Technology

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Example Occupations</th>
<th>Potential Impact of Computerization</th>
</tr>
</thead>
</table>
| **Routine Tasks** | `• ‘Rules-based’`  
`• Repetitive`  
`• Procedural` | `• Bookkeepers`  
`• Assembly line workers` | `• Direct Substitution` |
| **Abstract Tasks** | `• Abstract problem-solving`  
`• Mental flexibility` | `• Scientists`  
`• Attorneys`  
`• Managers`  
`• Doctors` | `• Strong Complementarity` |
| **Manual Tasks** | `• Environmental Adaptability`  
`• Interpersonal Adaptability` | `• Truck drivers`  
`• Security guards`  
`• Flight attendants`  
`• Home health aides`  
`• Waiters`  
`• Cleaners` | `• Limited Complementarity or Substitution` |
U.S. Job Task Input by Education Group in 1980

Autor, Levy and Murnane, 2003
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Employment Polarization, 1979 – 2010
Percent Growth in Employment by Occupation

Percent Change in Employment by Occupation, 1979-2010

-2  -1  0  1  2  3  4  5  6


-0.2  -0.1  0  0.1  0.2  0.3  0.4  0.5  0.6

-2  -1  0  1  2  3  4  5  6

Personal Care  Food/Cleaning Service  Protective Service  Operators/Laborers  Production  Office/Admin  Sales  Technicians  Professionals  Managers

Bar chart showing the percent growth in employment by occupation from 1979 to 2010.
Changes in Employment Share by Job Skill Tercile, 1993-2006
Comparison of U.S. and European Union Countries

Source: Goos, Salomons and Manning (2009)
<table>
<thead>
<tr>
<th>OCCUPATION</th>
<th>NUMBER OF NEW JOBS (PROJECTED), 2010–20</th>
<th>2010 MEDIAN PAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registered Nurses</td>
<td>711,900</td>
<td>$64,600 per year.</td>
</tr>
<tr>
<td>Retail Salespersons</td>
<td>706,800</td>
<td>$20,670 per year.</td>
</tr>
<tr>
<td>Home Health Aides</td>
<td>706,300</td>
<td>$20,560 per year.</td>
</tr>
<tr>
<td>Personal Care Aides</td>
<td>607,000</td>
<td>$19,640 per year.</td>
</tr>
<tr>
<td>Office Clerks, General</td>
<td>489,500</td>
<td>$26,610 per year.</td>
</tr>
<tr>
<td>Combined Food Preparation and Serving Workers, Including Fast Food</td>
<td>398,000</td>
<td>$17,950 per year.</td>
</tr>
<tr>
<td>Customer Service Representatives</td>
<td>338,400</td>
<td>$30,460 per year.</td>
</tr>
<tr>
<td>Heavy and Tractor-Trailer Truck Drivers</td>
<td>330,100</td>
<td>$37,770 per year.</td>
</tr>
<tr>
<td>Laborers and Freight, Stock, and Material Movers, Hand</td>
<td>319,100</td>
<td>$23,460 per year.</td>
</tr>
<tr>
<td>Postsecondary Teachers</td>
<td>305,700</td>
<td>$62,050 per year.</td>
</tr>
<tr>
<td>Nursing Aides, Orderlies, and Attendants</td>
<td>302,000</td>
<td>$24,010 per year.</td>
</tr>
<tr>
<td>Childcare Workers</td>
<td>252,000</td>
<td>$19,300 per year.</td>
</tr>
<tr>
<td>Bookkeeping, Accounting, and Auditing Clerks</td>
<td>259,000</td>
<td>$34,030 per year.</td>
</tr>
<tr>
<td>Cashiers</td>
<td>250,200</td>
<td>$18,500 per year.</td>
</tr>
<tr>
<td>Elementary School Teachers, Except Special Education</td>
<td>248,800</td>
<td>$51,660 per year.</td>
</tr>
<tr>
<td>Receptionists and Information Clerks</td>
<td>248,500</td>
<td>$25,240 per year.</td>
</tr>
<tr>
<td>Janitors and Cleaners, Except Maids and Housekeeping Cleaners</td>
<td>246,400</td>
<td>$22,210 per year.</td>
</tr>
</tbody>
</table>
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But the Luddites did have something to fear.

Ned Ludd

“Machine Trashing”
1812 – 1813
Technology Anxiety: Should We Worry?

• **What neoclassical economic theory predicts**

  a. There is a market-clearing wage – but it need only be weakly positive

  b. Labor’s share of national income can *rise or fall* – Capital *can* directly displace labor

  c. Rising productivity not necessarily *Pareto* improving – Raises national income, but can be winners *and* losers
Less Educated Workers Have Seen Falling Wage, Falling Employment to Population Rates

Changes in Wages and Employment, 1979 - 2007
by Education and Sex

Change in Real Hourly Wages (%)

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Males</th>
<th>Females</th>
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<tbody>
<tr>
<td>&lt; High School</td>
<td></td>
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<tr>
<td>High School Grad</td>
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<tr>
<td>Some College</td>
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<tr>
<td>College Grad</td>
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Change in Emp/Pop (% Pts)

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<tr>
<th>Education Level</th>
<th>Males</th>
<th>Females</th>
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<tbody>
<tr>
<td>HS Dropout</td>
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<tr>
<td>HS Graduate</td>
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<tr>
<td>Some College</td>
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<tr>
<td>College Graduate</td>
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Technology Anxiety: Is There a Cure?

1. **Three views of the problem**
   a. We lack imagination
   b. We have a labor demand problem
   c. We have an income distribution problem

2. **Worst case economic scenario**
   • Horses – The fax machines of the pre-automotive era

3. **Education: “America’s best idea”**
   • Effective for raising incomes and economic mobility
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Cross-Sectional Income Inequality and Intergenerational Earnings Elasticity

Source: Corak (2012)
Relative mobility

% adult children in each income quintile by birth quintile

Percent

<table>
<thead>
<tr>
<th>Adult income quintile:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Top</th>
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Bengali and Daly, 2013
Perhaps the most dramatic example of the importance of family background is shown by comparing adult children of parents in the top quintile who did not attain a college degree with adult children of parents in the bottom quintile who did attain a college degree. Children of parents in the top quintile have a 23 percent chance of winding up in the top quintile even though they fail to earn a college degree. Adult children of parents in the bottom quintile have only a 19 percent chance of winding up in the top quintile even when they get a college degree. Hard work can help students from poor families get ahead, but children from wealthy families nonetheless seem to have an advantage.

Given the powerful effect of a college education on the income of adult children from all levels of family income, the effects of family background and college education could be difficult to separate if parents with more income are more likely to have children who attain a college degree. Figure 7, which is similar to many other reports in the literature, shows that wealthier parents are indeed more likely to have children who attain a college degree. Only 11 percent of children with parents in the bottom income quintile attain a college degree as compared with 53 percent of children with parents in the top income quintile. These results are consistent with the conclusion that relatively wealthy parents pass along their advantages to their children is by ensuring that they attend and graduate from college.

The evidence shows that both education and family background have an impact on absolute and relative mobility. Despite the fact that family background helps adult children get ahead or stay ahead, high educational attainment can make a difference by boosting the fortunes of poor children and allowing them both to earn more than their parents and even to surpass the income of many of their peers from wealthier families. Because education has the potential to boost the economic mobility of poor children, it is important to ask whether the nation's educational systems do enough to promote economic mobility.

When they believe the game is not rigged, Americans generally are not alarmed by the nation's growing income inequality: Americans want to be certain that everyone who works hard and plays by the rules has a decent shot at a good education and the income mobility that will result in most cases. Although it would be difficult to achieve consensus on precisely how much economic mobility would be ideal, most Americans would probably agree that more mobility is good and that it would be consistent with American values if more children from low-income families had a better chance of moving up the economic ladder—especially through educational achievement—than they do now.

Thus, it seems fitting that at least since the Civil War, parents, the public, and politicians have made great efforts to create educational institutions that would promote economic growth and give all children a good chance to achieve economic mobility. Those efforts have produced good results: as we have seen, the twentieth century was marked by economic mobility project: an initiative of The Pew Charitable Trusts.
Figure 19a: Fraction of Students Entering College, by Income Quartile and Birth Year

- 1979 to 1982 birth cohorts
- 1961 to 1964 birth cohorts

Figure 19b: Fraction of Students Completing College, by Income Quartile and Birth Year

Of course, Education Does Not Erase All Advantages of Family Background.
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