Technology Anxiety Past and Present

David H. Autor, MIT and NBER

Man and Machine: The Impact of Technology on Employment
February 28, 2013
1. Technology anxiety – Past and present
2. What is distinctive about the computer revolution?
3. Changes in occupations: A detailed look
4. The difficulty of forecasting
5. Luddites revisited – What neoclassical theory says
6. Final thoughts
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
Are We Entering the “PC Era” of Workplace Robotics?

Rodney Brooks, CEO Rethink Robotics, 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
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
Traditional Economic View

1. **Technological change is a win-win**
   - The only free lunch that economists can believe in (Mokyr, 1990)

2. **Labor demand is unlimited**

3. **Those who fear technological change are “Luddites.”**
An Earlier Era of Technology Anxiety

Ned Ludd

“Machine Trashing”
1812
Over the Course of a Century…

Chart 38. *Income deflated to 1901 for the United States, New York City, and Boston*

![Graph showing income deflation](chart.png)

Over the Course of a Century...

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

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

Johnston 2012
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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.
<table>
<thead>
<tr>
<th>Task Description</th>
<th>Example Occupations</th>
<th>Potential Impact of Computerization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Routine Tasks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• ‘Rules-based’</td>
<td>• Bookkeepers</td>
<td>• Direct Substitution</td>
</tr>
<tr>
<td>• Repetitive</td>
<td>• Assembly line workers</td>
<td></td>
</tr>
<tr>
<td>• Procedural</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Abstract Tasks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Abstract problem-solving</td>
<td>• Scientists</td>
<td>• Strong Complementarity</td>
</tr>
<tr>
<td>• Mental flexibility</td>
<td>• Attorneys</td>
<td></td>
</tr>
<tr>
<td>• Managers</td>
<td>• Doctors</td>
<td></td>
</tr>
<tr>
<td><strong>Manual Tasks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Environmental Adaptability</td>
<td>• Truck drivers</td>
<td>• Limited Complementarity or Substitution</td>
</tr>
<tr>
<td>• Interpersonal Adaptability</td>
<td>• Security guards</td>
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</tr>
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<td></td>
<td>• Flight attendants</td>
<td></td>
</tr>
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<td></td>
<td>• Home health aides</td>
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<td></td>
<td>• Waiters</td>
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<tr>
<td></td>
<td>• Cleaners</td>
<td></td>
</tr>
</tbody>
</table>
U.S. Job Task Input by Education Group, 1980 Averages

Autor, Levy and Murnane, 2003
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Autor, Levy and Murnane ‘03 Figure 1: Economy Wide Changes in Job Task Content 1960 - 1998

Figure I. Trends in Routine and Nonroutine Task Input, 1960 to 1998.
ALM Update: Non-Routine Cognitive Task Measures to 2009

Non-routine Cognitive Tasks: ALM Originals and Updates

Mean Task Input in Percentiles of 1960 Task Distribution

Non-routine Analytical (Updated)  Non-routine Analytical (ALM)
Non-routine Interpersonal (Updated)  Non-routine Interpersonal (ALM)
ALM Update:
Non-Routine Manual Task Measure to 2009

Non–routine Manual Tasks: ALM Originals and Updates

Mean Task Input in Percentiles of 1960 Task Distribution

- 1960
- 1970
- 1980
- 1990
- 2000
- 2010

Non–routine Manual (Updated) Non–routine Manual (ALM)
Worker Tasks in the U.S. Economy, 1960 – 2009:

All Education Groups

Mean Task Input in Percentiles of 1960 Distribution

- Non-routine Analytical
- Non-routine Interpersonal
- Non-routine Manual
- Routine Cognitive
- Routine Manual

Autor, Levy and Murnane ‘03 Figure 1 Update: Economy Wide Changes in Job Task Content 1960 - 1998
The Impact of Another Decade’s Data


Worker Tasks in the U.S. Economy, 1960 – 1998:
Autor, Levy, and Murnane (2003) Figure 1

Worker Tasks in the U.S. Economy, 1960 – 2009:
All Education Groups
Routine Manual Tasks: Levels and Changes

Routine Manual Tasks 1960 - 2009: Overall and by Sex

All Education Groups

Mean Task Input in Percentiles of 1960 Task Distribution

All Males Females

Routine Manual Tasks 1960 - 2009: Overall and by Sex
Nonroutine Analytical Tasks: Levels and Changes

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Mean Task Input in Percentiles of 1960 Task Distribution

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All Education Groups

Non-Routine Manual Tasks 1960 - 2009: Overall and by Sex
Employment Polarization, 1979 – 2009

Percent Growth in Employment by Occupation

Percent Change in Employment Share 1980-2009
by Age Group and Major Occupation

Males

Females

Services
Prod/ Craft/ Oper/ Laborer
Clerical/ Admin/ Sales
Prof/ Tech/ Managers

Males

Females

Ages 25-39

Ages 40-64

Ages 25-39

Ages 40-64
Changes in Employment Share by Job Skill Tercile, 1993-2006
Comparison of U.S. and European Union Countries

Source: Goos, Salomons and Manning (2009)
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Projection Occupational Employment Trends: Gasoline Service Station Attendants

• **1976 projections**

  • “Employment of gasoline service station attendants should continue to grow over the next few years....
  
  • ...The trend towards cars better gas mileage capabilities could eventually reduced total gasoline consumption, which might severely limited growth in this occupation over the long run.
  
  • ...*Self-service gas stations may also limit growth.*”

• **2002/03 projections**

  • Service station attendants (0*NET 53-6031.00).
  
  • Service automobiles, buses, trucks, boats, and other automotive or marine vehicles with fuel, lubricants, and accessories.
  
  • *Projected 2000-10 employment change: A decline*
1968

• “Important clerical occupations such as secretaries, stenographers, typists, cashiers, bank tellers, mail carriers, postal clerks, and telephone operators are not expected to be heavily affected by the use of computers...”

1980

• “Technological innovations will not affect many types of clerical workers whose jobs involve a high degree of personal contact.”

1992

• “… Employment of bank tellers is not expected to keep pace with overall employment growth in banks and other savings and credit institutions because of the increasing use of automatic teller machines...”

2000

• “… The increased use of ATM machines and Internet banking will reduce the number of tellers.”
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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.”**
But Luddites Had Something to Fear…

Ned Ludd

“Machine Trashing”
1912 – 1913
Technology Anxiety: Should we Worry?

• What the neoclassical theory predicts
  
a. There is a market-clearing wage, but it need only be weakly positive
  
b. Labor’s share can rise or fall
  
c. Rising productivity passes the Kaldor-Hicks test, but not necessarily the Pareto test
Percentage Point Changes in Real Hourly Wages by Education and Sex, 1979-2010

Ages 25-39

- High School
- High School Grad
- Some College
- College Grad
- Post-College

Males
Females

Ages 40-64

- High School
- High School Grad
- Some College
- College Grad
- Post-College

Males
Females

Autor and Wasserman, 2013
Percentage Point Changes in Emp/Pop Rates by Education and Sex, 1979-2010

Changes in Employment to Population Rates by Sex and Education Group: Ages 25-64

1979-2007

- HS Dropout
- HS Graduate
- Some College
- College Graduate
- Postcollege

- Males
- Females

2007-2010

- HS Dropout
- HS Graduate
- Some College
- College Graduate
- Postcollege

- Males
- Females

Autor and Wasserman, 2013
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