Drivers of changing job skill requirements

Demand for skills based on

1. **Kinds of goods/services demanded** (composition of final demand)
2. **Methods of production** (technology, knowledge, organization, prod. function)
3. **Trade/Outsourcing** (final demand may not → domestic labor demand)
4. **Qualities of workforce** (human capital, wages, feed back on 2 & 3)
5. **Overall level of demand** (macroeconomic conditions)

1. **Long-run shift from goods to services** (health care, education, food service, hospitality/leisure—but also natural resource boom)
2. **Long-run shift to WC work—reflects knowledge and hard technology** (mgrs/profls/assoc profls—but also service proletariat, non-standard empl., clericals)
3. **Globalizing labor market** (China vs. Japan, only low wages or also high skills?)
4. **Is education keeping up?**
5. **Demand insufficiency underappreciated**

Theme: Skills and IT very important...but keep in perspective
Dimensions of skill demand and change

1. What is current level of skills used in economy?
2. What kinds of skills used? (e.g., STEM)
3. Rate and pattern of change
   a. Accelerating, decelerating (halting), stable
   b. Timing—smooth, period-specific, business cycle influence
   c. Polarizing or upgrading dominant

Conceptual and practical consideration
1. Between-occupation skill shifts—data plentiful
2. Within-occupation skill shifts—data scarce
Preview and general perspective

1. Long-run changes in final demand and technology generally favor more skilled, disfavor blue-collar work

2. Most change is gradual
   a. Effects of mechanization predate IT
   b. Technology develops and diffuses gradually
   c. Workforce composition changes gradually (cohort replacement, within-cohort change)

3. Some sectors experience unusually rapid change (potential overgeneralizing bias)

4. Current level of skill requirements easy to exaggerate

5. Timing of skill changes often hard to reconcile with simple IT story

6. Overall level of labor demand critical (macroeconomy)
II. Evidence

A. **Occupational trends** *(1950-2020)*
B. **Trends in some technologically sensitive occupations**
C. **Skill score trends** *(1987-2009)*
   i. O*NET
   ii. Essential Skills
D. **More detailed cross-sectional view of skills used at work—**
   STAMP survey
Occupation—ISCO classification

- Managers
- Professionals, technical workers, and associate professionals
- Clerical
- Sales
- Service
  - food service, hospitality, care work
- Farm
- Production and related (all skill levels)
  - craft, operators & assemblers, labourers, elementary occupations

Breaks in series—aggregation helps, but problems remain

Advantages: Long-run perspective, manageable number of intuitive groups

Disadvantages: Coarse measures of skill, lots of skill diversity within groups
Long-run occupational trends
Occupational trends—conclusions

Long-run trends show clear stages

- **Farm occupations** decline steeply when ≥ 20% of workforce

- **Production jobs** dominate next phase—advanced countries:
  - peak 45% (1950s-1960s) and now <25%
  - Declines 25% in 50 years, usually predates computers

- **Professionals/assoc profls/managers** predominate now
  - 10% in 1960 and 35% now
  - Mostly overtaken production workers

- **Clerical and sales** grew from 1960-1990, now flat or small decline
  - clerical most affected by computers so far...

- **Service occupations** growing, but not quickly

Projections show no acceleration to 2020
Specific occupations sensitive to technology—STEM

1% per decade
1.65% per decade

IT
STEM
Total
Health
Specific occupations sensitive to technology—bank tellers
Specific occupations sensitive to technology—clerical workers

-1.25% per decade

-0.35% per decade
Future possibilities

- New high tech jobs will emerge and grow (chief data scientist)
- Some existing occupations cut back (simple retail, publishing, MOOCs)
- Most change likely gradual
Broad occupations are coarse skill measures

Skill scores apply to detailed occupations and more specific
...but available for shorter period (1987-2009)

• O*NET
• Essential Skills
B. O*NET SKILL MEASURES—summary

1. Job’s required education (years)  
   Cognitive—overall academic skills

2. * Math

3. * Verbal (reading, writing)  
   Cognitive—finer dimensions

4. * General cognitive demands

5. * People skills  
   Interpersonal skills

6. * Craft skills (install, maintain, repair)  
   Manual skills

7. * Gross physical requirements

8. Repetitive motions (time spent)

* Measures 2-7 are composite scales in standardized metric (U.S. 1992 = 1.0)
Results

• **U.S., EU, Canada show very similar levels and trends** (1997-2009)
• Differences between Canada and U.S. small
• **Skill upgrading is the norm**
  • Rising job requirements for education, verbal, math, and general cognitive skills
    - Math requirements not rising faster than others
  • Increasingly interpersonal nature of work
    - Not strongly rewarded in labor market (wages)
    - More prominent but not necessarily requiring huge concern
• Craft, physical, and repetitive work declining
  - But not very rapidly—lots of these jobs remain
• **Trends are uniformly gradual**
  • No acceleration
Focus on Canada

Using one system \((O^*NET)\) for all countries permits comparison

...but maybe U.S. skill measures don’t apply to other countries

Canadian **Essential Skills** (ES) database can be compared to O*NET

---

**Essential Skills scales and items**

1. **Verbal:** (1) complex reading, (2) complex writing \((\alpha=0.80)\)

2. **Math:** (1) scheduling, budgeting, accounting, (2) measurement and calculation, 
   (3) data analysis, (4) numerical estimation \((\alpha=0.65)\)

3. **General cognitive:** (1) typical problem solving, (2) typical decision making, (3) complex 
   critical thinking, (4) typical job task planning, (5) complex information finding \((\alpha=0.78)\)

4. **Complex oral communication:** single question
Both O*NET and Essential Skills measures can be used to chart Canadian skill trends for 1987-2009

Both show consistent results:

• Skill upgrading in 1989-1994
• Mostly flat trend for 1994-2004
• Resumption of upgrading for 2004-2009 business cycle?
• O*NET and ES track one another well
• All trends gradual (though charts show close-ups)
Trends in required education, cognitive and verbal skills, Canada 1987-2009
Trends in required math skills, Canada 1987-2009
Trends in required interpersonal skills, Canada 1987-2009
Trends in repetitive tasks (time spent) and manual job requirements, Canada 1987-2009

- **Repetitive tasks**
  - Year: 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, 05, 06, 07, 08, 09
  - Score range: 3.08 to 3.20

- **Craft and Physical demands scores**
  - Year: 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, 05, 06, 07, 08, 09
  - Score range: -0.10 to 0.06

- **Chart details:**
  - **Repet_ONET**
  - **Craft-ONET**
  - **Phys-ONET**

- **Key trends:**
  - A downward trend in repetitive tasks and craft and physical demands scores from 1987 to 2009.
  - The scores for repetitive tasks show a slight increase from 2005 to 2007.
A deeper cross-sectional picture

Survey of Skills, Technology, and Management Practices (STAMP)

• Nationally representative probability sample telephone survey
• Employed wage & salary workers, age 18 and over
• English & Spanish language versions
• 166 job-specific questions, 28 mins. average length
• Covers
  o math, reading, writing
  o problem solving
  o IT and other technology use
  o interpersonal and manual tasks
  o teams and employee involvement practices
  o pay, promotion, position, workload, job satisfaction
• Sole source of representative information for most items—some on PIAAC
## Math use at work by occupation

<table>
<thead>
<tr>
<th>Percentage (weighted)</th>
<th>All</th>
<th>Upper WC</th>
<th>Low WC</th>
<th>Upper BC</th>
<th>Low BC</th>
<th>Service</th>
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<tr>
<td>100</td>
<td>36.1</td>
<td>25.4</td>
<td>10.3</td>
<td>13.0</td>
<td>15.1</td>
<td></td>
</tr>
</tbody>
</table>

| N (unweighted) | 2,304 | 1,010 | 569 | 161 | 271 | 291 |

### Percentage using:

1. **Any math**
   - 94
   - 95
   - 97
   - 94
   - 91
   - 88

2. **Add/subtract**
   - 86
   - 93
   - 90
   - 87
   - 78
   - 73

3. **Multiply/divide**
   - 78
   - 89
   - 82
   - 81
   - 65
   - 57

4. **Fractions**
   - 68
   - 82
   - 68
   - 70
   - 58
   - 40

   *Any more advanced*

   - 22
   - 35
   - 9
   - 41
   - 19
   - 4

5. **Algebra (basic)**
   - 19
   - 30
   - 8
   - 36
   - 16
   - 4

6. **Geometry or trig**
   - 14
   - 20
   - 5
   - 29
   - 15
   - 2

7. **Statistics**
   - 11
   - 22
   - 5
   - 10
   - 6
   - 2

8. **Algebra (complex)**
   - 9
   - 14
   - 3
   - 16
   - 8
   - 2

9. **Calculus, similar**
   - 5
   - 8
   - 1
   - 8
   - 5
   - 1
### Reading and Writing (percentages, except bottom row)

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>High WC</th>
<th>Low WC</th>
<th>High BC</th>
<th>Low BC</th>
<th>Service</th>
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<tbody>
<tr>
<td><strong>Reading</strong></td>
<td></td>
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<td></td>
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<td></td>
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<td>1. Any reading</td>
<td>96</td>
<td>99</td>
<td>97</td>
<td>91</td>
<td>91</td>
<td>95</td>
</tr>
<tr>
<td>2. One page</td>
<td>82</td>
<td>96</td>
<td>86</td>
<td>72</td>
<td>57</td>
<td>67</td>
</tr>
<tr>
<td>3. Five pages</td>
<td>54</td>
<td>81</td>
<td>47</td>
<td>46</td>
<td>26</td>
<td>32</td>
</tr>
<tr>
<td>4. News articles, et al.</td>
<td>42</td>
<td>64</td>
<td>37</td>
<td>27</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>5. Prof'l articles</td>
<td>38</td>
<td>65</td>
<td>26</td>
<td>24</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>6. Books</td>
<td>53</td>
<td>76</td>
<td>40</td>
<td>53</td>
<td>35</td>
<td>38</td>
</tr>
<tr>
<td><strong>Writing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Any writing</td>
<td>91</td>
<td>99</td>
<td>93</td>
<td>83</td>
<td>80</td>
<td>83</td>
</tr>
<tr>
<td>2. One page</td>
<td>61</td>
<td>86</td>
<td>56</td>
<td>46</td>
<td>36</td>
<td>41</td>
</tr>
<tr>
<td>3. Five pages</td>
<td>24</td>
<td>47</td>
<td>13</td>
<td>12</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>4. News articles, et al.</td>
<td>9</td>
<td>20</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>5. Books/prof'l arts</td>
<td>3</td>
<td>7</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Documents</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Use any forms</td>
<td>67</td>
<td>78</td>
<td>77</td>
<td>61</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>2. Form complexity</td>
<td>3.16</td>
<td>3.99</td>
<td>3.65</td>
<td>2.62</td>
<td>1.84</td>
<td>1.86</td>
</tr>
</tbody>
</table>

*a. Articles or reports for magazines, newspapers, or newsletters.*

*b. Articles for scholarly, scientific, or professional journals*

*c. Mean values on a rating scale ranging from 0=no form use, 1 = extremely simple, 11 = extremely complicated (0=no form use).*
# Computer use at work

(percentages except rows 11-12)

<table>
<thead>
<tr>
<th>Activity</th>
<th>All</th>
<th>High WC</th>
<th>Low WC</th>
<th>High BC</th>
<th>Low BC</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Data entry most of time</td>
<td>14</td>
<td>14</td>
<td>31</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2. Spreadsheets</td>
<td>40</td>
<td>64</td>
<td>44</td>
<td>13</td>
<td>18</td>
<td>14</td>
</tr>
<tr>
<td>3. Spreadsheet macros, equations</td>
<td>12</td>
<td>21</td>
<td>11</td>
<td>2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>4. Databases</td>
<td>19</td>
<td>32</td>
<td>20</td>
<td>7</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>5. SQL database queries</td>
<td>3</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6. CAD</td>
<td>7</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>7. Science/engineering tasks</td>
<td>7</td>
<td>14</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8. Programming</td>
<td>4</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9. Special software</td>
<td>47</td>
<td>61</td>
<td>59</td>
<td>23</td>
<td>29</td>
<td>24</td>
</tr>
<tr>
<td>10. New software in last 3 years(^a)</td>
<td>16</td>
<td>24</td>
<td>16</td>
<td>11</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>11. No. of applications (max=15)</td>
<td>4.02</td>
<td>6.06</td>
<td>4.68</td>
<td>1.68</td>
<td>1.91</td>
<td>1.41</td>
</tr>
<tr>
<td>12. Computer skill level(^b)</td>
<td>4.21</td>
<td>5.91</td>
<td>5.06</td>
<td>1.95</td>
<td>2.43</td>
<td>1.77</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skill</th>
<th>All</th>
<th>High WC</th>
<th>Low WC</th>
<th>High BC</th>
<th>Low BC</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate skills (users only)</td>
<td>23</td>
<td>26</td>
<td>18</td>
<td>30</td>
<td>23</td>
<td>22</td>
</tr>
<tr>
<td>Affected pay/promotion</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>10</td>
<td>18</td>
<td>13</td>
</tr>
</tbody>
</table>

\(^a\) Learn any new programs or functions taking >1 week to learn.

\(^b\) Self-rated complexity of computer skills used on job (0=no computer use, 1=very basic, 11=very complex)
Machinery—traditional and automated (percentages except rows 17-18)

<table>
<thead>
<tr>
<th>Activity</th>
<th>All</th>
<th>High WC</th>
<th>Low WC</th>
<th>High BC</th>
<th>Low BC</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Heavy Machinery</td>
<td>20</td>
<td>7</td>
<td>11</td>
<td>65</td>
<td>46</td>
<td>12</td>
</tr>
<tr>
<td>2. Maintenance</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>41</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>3. Repair</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>35</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>4. Machine set-up</td>
<td>12</td>
<td>4</td>
<td>4</td>
<td>41</td>
<td>29</td>
<td>8</td>
</tr>
<tr>
<td>5. Use machine tools</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>6. Use NC / CNC</td>
<td>2</td>
<td></td>
<td></td>
<td>3</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>7. Program NC / CNC</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>8. Operate robots</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>9. Program robots</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>10. PLCs</td>
<td>2</td>
<td>1</td>
<td></td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>11. CPC</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>14</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>12. Program CPC</td>
<td>1</td>
<td>1</td>
<td></td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>13. Automated equipment</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>14. Assembly line</td>
<td>2</td>
<td></td>
<td></td>
<td>1</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>15. New machinery in 3 yrs.</td>
<td>10</td>
<td>4</td>
<td>4</td>
<td>32</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>16. Learning time &gt; 1 week</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>13</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>17. Mechanical Skill Levela</td>
<td>2.50</td>
<td>1.73</td>
<td>1.38</td>
<td>5.97</td>
<td>4.55</td>
<td>2.12</td>
</tr>
<tr>
<td>18. Electronics Skill (1=yes)</td>
<td>13</td>
<td>12</td>
<td>8</td>
<td>33</td>
<td>15</td>
<td>9</td>
</tr>
</tbody>
</table>

Blank cells = values round to zero. NC = numerically-controlled machine tool (1=yes), CNC = computer numerically-controlled machine tool (1=yes), PLC = programmable logic controllers (1=yes), CPC = computer process control (1=yes)

a. Mechanical skills: 0 = very basic, 10 = very complex
III. Policy implications

A. Limits of skills policies

B. Roles of skills policies
   i. Labor market information
   ii. Clarifying: What skills and what groups
   iii. Improving outcomes
A. Limits of skills policies

1. Macro labor market health is critical

The most effective
- training
- education
- placement services
- work incentives

will face extraordinary headwinds if jobs are scarce

Skills are not a cure-all

Costs of high unemployment:
- Long-run (lifetime) pay losses for new grads, displaced older workers
- Scarring, skill & training investments depreciate due to disuse
- Early retirements (exits) increase rather than decrease (policy goal)

Current slack economy an unambiguous bad
Macroeconomic policy is labor policy

What other steps can be taken?
B. Roles of skills policies—labor market information

Need to improve programs to monitor skill trends (all OECD countries)

Occupation, O*NET, and ES trends useful but greater detail possible

OECD countries:
• work toward a common system for measuring job skill requirements
• collect job skill data on a regular basis

No real way otherwise to track country progress and benchmark internationally
Link to occupation projections to forecast skill demand

Example: STAMP survey some items on PIAAC
B. Roles of skills policies—labor market information

Other measures? Stakeholders want very granular information...

Might never satisfy them, but other possible improvements:

• Passive data collection  e.g., field of study data from provider databases
• Internet data mining  e.g., O*NET Technology and Tools database
• Improved input from sector skills councils  UK example

Forecasts—Always imperfect....who could foresee:

• predicted U.S. STEM “crisis” of early 1990s would be glut instead
• relatively smooth absorption of ex-welfare clients in booming late 1990s
• IT & telecom booms and busts  late 1990s
• biotech’s fluctuations, nanotech’s emergence
• the financial crisis  (construction, financial services, law....every field impacted)
• current energy boom  ...and its future
• green jobs’ real potential
• China’s future impacts
But all countries will see increased demand for healthcare!

All OECD country projections show this

Fairly predictable:
• Demographics of population aging
• Income effects on demand for healthcare consistent

Shortage? Depends on:
• Supply response
• Cost containment
B. Roles of skills policies—clarifying

Policy coherence requires clear framework for
  (a) skill types and levels  (b) diverse job-seekers

Skill types and levels outlined in Slide 5—each category needs own strategy

Skills also means very different things to different groups, different needs
  • young workers—immaturity vs. poor skills, work readiness
  • older workers—inflexible, not tech savvy?
  • displaced long-tenure workers—manuf. prod. workers’ special risk
  • all workers with a HS degree or less
  • only disadvantaged groups
  • STEM

All need policy consideration, but clearly no single “skills problem”

Avoid generalities—think concretely, systematically—who? which? what? Jobs and people diverse, simple formulas misleading
B. Roles of skills policies—improving outcomes

The Holy Grail—clearly difficult, much has been tried

Job information too disconnected from school—young people narrow options early and unknowingly—improve education on job requirements, pay, other dimensions

Improve understanding:
• barriers to educational attainment alienation, low information/support, finances
• industry certificates a partial solution?

Expand cooperative education, subsidies for in-demand fields of study

Promote employer training industry consortia, training tax
Improving outcomes—investigate training

Training programs disappointing even in good times, but why?

Many outcome studies, but reasons murky—qualitative evidence useful

• Students don’t meet learning goals—life pressures (health, transportation, childcare), ability/motivation, poor instructors

• Goals are too low to matter to employers—courses too brief and shallow, not enough training

• Course content doesn’t meet employer needs—wrong kind of training

• Jobs scarce for these kinds of workers despite transmission of valuable skills

• Programs and participants have poor reputations among employers, scarring

• Participants have job barriers that training won’t solve—long gaps in employment history, add job subsidies? Selection effects
Conclusions

• Long-run trends show stage pattern
  o Farm to Manual to Knowledge Jobs
  o But transition to post-industrial economy slower

• Job skill requirements rising
  o change is gradual
  o ....but it adds up over time (decades)

• No indication of acceleration in projections
  o manual jobs not returning

• Full employment is key to meeting goals

• More detailed tracking of skill trends possible
• More coherent and effective skills policies possible
Annex
<table>
<thead>
<tr>
<th>Occupation</th>
<th>1960</th>
<th>2009</th>
<th>50-60</th>
<th>60-70</th>
<th>70-80</th>
<th>80-90</th>
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Canada

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Germany

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<th>60-70</th>
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Other OECD

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<th>60-70</th>
<th>70-80</th>
<th>80-90</th>
<th>90-00</th>
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<tr>
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<td>-3.0</td>
<td>-3.9</td>
<td>-4.4</td>
<td>-3.3</td>
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</table>
O*NET SKILL MEASURES—details (62 items)

1. **Job’s required education** (in years)

2. **Math:** (1) mathematics skills; (2) mathematics knowledge; (3) mathematical reasoning; (4) number facility (α=0.92)

3. **Verbal:** (1) reading comprehension; (2) writing skills; (3) writing comprehension; (4) writing ability; (5) knowledge of English language rules (spelling, grammar, composition); (6) frequency of using written letters and memos (α=0.95)

4. **General cognitive:** (1) analytical thinking; (2) critical thinking; (3) complex problem solving; (4) active learning; (5) analyzing data or information; (6) processing information; (7) thinking creatively; (8) updating and using relevant knowledge; (9) deductive reasoning; (10) inductive reasoning; (11) fluency of ideas; (12) category flexibility (α=0.97)

5. **People skills:** (1) persuasion; (2) negotiation; (3) speaking skills; (4) frequency of face-to-face discussions; (5) frequency of public speaking; (6) communicating with persons outside organization; (7) dealing with external customers or public; (8) performing for or working directly with the public; (9) customer and personal service knowledge; (10) service orientation; (11) dealing with angry people; (12) dealing with physically aggressive people; (13) frequency of conflict situations; (14) resolving conflicts and negotiating with others; (15) instructing skills; (16) training and teaching others; (17) education and training knowledge; (18) interpreting the meaning of information for others; (19) social orientation; (20) social perceptiveness (α=0.94)

6. **Craft skills:** (1) controlling machines and processes; (2) repairing and maintaining mechanical equipment; (3) repairing and maintaining electronic equipment; (4) equipment maintenance; (5) repairing machines; (6) troubleshooting operating errors; (7) installing equipment, machines, and wiring (α=0.95)

7. **Gross physical requirements:** (1) handling and moving objects; (2) general physical activities; (3) static strength; (4) dynamic strength; (5) trunk strength; (6) stamina; and time spent (7) sitting, (8) standing, (9) walking, (10) twisting body, (11) kneeling, crouching, stooping, or crawling (α=0.98)

8. **Repetitive motions:** time spent making repetitive motions (1=never, 2=less than half time, 3=about half time, 4=more than half time, 5=continually or almost continually)
### Mean skill scores using O*NET measures, 1997-2009

<table>
<thead>
<tr>
<th></th>
<th>Education</th>
<th>Cognitive</th>
<th>Math</th>
<th>Verbal</th>
<th>People</th>
<th>Craft</th>
<th>Physical</th>
<th>Repetitive</th>
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<td><strong>United States</strong></td>
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<td></td>
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<tr>
<td>1 1997</td>
<td>13.53</td>
<td>0.05</td>
<td>0.05</td>
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<td>0.11</td>
<td>0.17</td>
<td>-0.05</td>
<td>-0.02</td>
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<tr>
<td>3 Δ 1997-2009</td>
<td>0.15</td>
<td>0.07</td>
<td>0.03</td>
<td>0.07</td>
<td>0.11</td>
<td>-0.06</td>
<td>-0.02</td>
<td>-0.05</td>
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<td><strong>Europe panel (23 countries)</strong></td>
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<td></td>
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<td>4 1997</td>
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<td>5 2009</td>
<td>13.59</td>
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<td>-0.04</td>
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<td><strong>Canada</strong></td>
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<td><strong>Canada-US difference</strong></td>
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<tr>
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<td>-0.03</td>
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<td>-0.02</td>
<td>-0.06</td>
<td>-0.03</td>
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<tr>
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<td>-0.03</td>
<td>-0.01</td>
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Results (a)

O*NET and ES occupation scores for similar variables
Moderate correlations

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<th>O*NET</th>
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<td>People</td>
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## Results (b)

### Much stronger correlations with mean education and wages of Canadian occupations

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<th>O*NET &amp; ES</th>
<th>Canadian occupations</th>
<th>Education</th>
<th>Wages</th>
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<tr>
<td>Oral commun.</td>
<td>0.65</td>
<td>0.61</td>
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</table>

It is true that O*NET correlations are higher with U.S. education (+0.08) and wages (+0.16)

ES correlates more strongly with U.S. wages (+0.06) and equally well with U.S. education

Correlations between U.S. and Canadian education (0.85) and wages (0.82) are strong
## STAMP cognitive skill measures

### Percentage of employees using math, reading, and writing on their jobs

<table>
<thead>
<tr>
<th>Math (α=0.81)</th>
<th>%</th>
<th>Reading (α=0.80)</th>
<th>%</th>
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<tr>
<td>2. Add/subtract</td>
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<td>82</td>
</tr>
<tr>
<td>3. Multiply/divide</td>
<td>78</td>
<td>3. Five pages</td>
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</tr>
<tr>
<td>Any more advanced</td>
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<td>5. Prof'l articles</td>
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<tr>
<td>5. Algebra (basic)</td>
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<td>6. Books</td>
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<tr>
<td>6. Geometry/trig</td>
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<td>Writing (α=0.64)</td>
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<td>1. Any writing</td>
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<td>8. Algebra (complex)</td>
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<tr>
<td>9. Calculus</td>
<td>5</td>
<td>3. Five pages</td>
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<td></td>
<td></td>
<td>4. News articles</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Books/prof'l arts</td>
<td>3</td>
</tr>
</tbody>
</table>