Skills, Automation and Mega-projects

Construction Industry

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**OVERVIEW**

- Automation, Market Structure and Skills in the Construction Industry
- Frugal Innovation and cost over-runs in mega-projects
Humans versus Machines

“We can know more than we can tell . . .”

– Polanyi (1966)
Humans versus Machines

“We can know more than we can tell . . . ”
– Polanyi (1966)

“Google cars don’t drive on road, they drive on maps . . . ”
– saying in machine learning community
**Skill-Task distinction**

*Too many cooks spoil the broth*  
*Many hands make work light*

A *task* is a unit of work activity that produces output.  
*Skill* is worker’s inalienable stock of capabilities for performing various tasks.
**Task Framework**

<table>
<thead>
<tr>
<th></th>
<th>Routine Tasks</th>
<th>Non-Routine Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Abstract Tasks</td>
</tr>
<tr>
<td>Cognitive skills</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Non-cognitive skills</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manual Tasks</td>
</tr>
</tbody>
</table>

**Routine Tasks**: repetitive physical and mental operation in an unchanging environment and can be potentially codified

**Non-Routine Tasks**

- **Abstract Tasks**: require problem solving abilities, intuition, creativity and persuasion.
- **Manual Tasks**: require situational adaptability, visual and language recognition and in-person interaction.

**Offshorability** are tasks that can be relocated to a remote location without substantially degrading the quality of the output.

# Routinisation and Offshorability in Jobs

## Routine Task Intensity Index and Offshorability of European Occupations

<table>
<thead>
<tr>
<th>Occupations ranked by mean European wage</th>
<th>Routine Task Intensity Index</th>
<th>Offshorability</th>
<th>Employment Share in 1993</th>
<th>% change 1993 – 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-paying occupations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corporate managers</td>
<td>-0.72</td>
<td>-0.12</td>
<td>31.67</td>
<td>5.62</td>
</tr>
<tr>
<td>Physical, mathematical, and engineering professionals</td>
<td>-0.82</td>
<td>1.05</td>
<td>2.93</td>
<td>1.36</td>
</tr>
<tr>
<td>Life science and health professionals</td>
<td>-1.00</td>
<td>-0.76</td>
<td>2.01</td>
<td>0.57</td>
</tr>
<tr>
<td>Other professionals</td>
<td>-0.73</td>
<td>0.21</td>
<td>2.79</td>
<td>1.38</td>
</tr>
<tr>
<td>Managers of small enterprises</td>
<td>-1.52</td>
<td>-0.63</td>
<td>4.16</td>
<td>0.17</td>
</tr>
<tr>
<td>Physical, mathematical, and engineering associate professionals</td>
<td>-0.40</td>
<td>-0.12</td>
<td>4.44</td>
<td>0.21</td>
</tr>
<tr>
<td>Other associate professionals</td>
<td>-0.44</td>
<td>0.10</td>
<td>7.24</td>
<td>0.79</td>
</tr>
<tr>
<td>Life science and health associate professionals</td>
<td>-0.33</td>
<td>-0.75</td>
<td>2.45</td>
<td>0.55</td>
</tr>
<tr>
<td><strong>Middling occupations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stationary plant and related operators</td>
<td>0.69</td>
<td>0.24</td>
<td>46.75</td>
<td>-9.27</td>
</tr>
<tr>
<td>Metal, machinery, and related trade work</td>
<td>0.32</td>
<td>1.59</td>
<td>1.70</td>
<td>-0.25</td>
</tr>
<tr>
<td>Drivers and mobile plant operators</td>
<td>-1.50</td>
<td>-1.00</td>
<td>5.03</td>
<td>-0.48</td>
</tr>
<tr>
<td>Office clerks</td>
<td>2.24</td>
<td>0.40</td>
<td>10.60</td>
<td>-2.06</td>
</tr>
<tr>
<td>Precision, handicraft, craft printing, and related trade workers</td>
<td>1.59</td>
<td>1.66</td>
<td>1.45</td>
<td>-0.54</td>
</tr>
<tr>
<td>Extraction and building trades workers</td>
<td>-0.19</td>
<td>-0.93</td>
<td>1.45</td>
<td>-0.54</td>
</tr>
<tr>
<td>Customer service clerks</td>
<td>1.41</td>
<td>-0.25</td>
<td>7.35</td>
<td>-0.64</td>
</tr>
<tr>
<td>Machine operators and assemblers</td>
<td>0.49</td>
<td>2.35</td>
<td>2.13</td>
<td>0.06</td>
</tr>
<tr>
<td>Other craft and related trade workers</td>
<td>1.24</td>
<td>1.15</td>
<td>5.99</td>
<td>-1.63</td>
</tr>
<tr>
<td><strong>Low-paying occupations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labourers in mining, construction, manufacturing, and transport</td>
<td>-0.08</td>
<td>-0.84</td>
<td>21.56</td>
<td>3.65</td>
</tr>
<tr>
<td>Personal and protective service workers</td>
<td>-0.60</td>
<td>-0.94</td>
<td>6.86</td>
<td>2.36</td>
</tr>
<tr>
<td>Models, salespersons, and demonstrators</td>
<td>0.05</td>
<td>-0.89</td>
<td>6.06</td>
<td>-0.11</td>
</tr>
<tr>
<td>Sales and service elementary occupations</td>
<td>0.03</td>
<td>-0.81</td>
<td>4.38</td>
<td>1.95</td>
</tr>
</tbody>
</table>
# Routinisation and Offshorability in Jobs

## Routinisation and Offshorability in Occupations

<table>
<thead>
<tr>
<th>Occupations</th>
<th>Non-Routine Occupations</th>
<th>Routine Occupations</th>
</tr>
</thead>
</table>
| Low-offshorability | *High Paying occupations*  
*Corporate managers*  
*Life science and health professionals*  
*Managers of small enterprises*  
*Physical, mathematical, and engineering associate professionals*  
*Life science and health associate professionals*  
*Middling Occupations*  
*Drivers and mobile plant operators*  
*Extraction and building trades workers*  
*Low-paying occupations*  
*Personal and protective service workers* | *Middling Occupations*  
*Metal, machinery, and related trade work*  
*Customer service clerks*  
*Low-paying occupations*  
*Labourers in mining, construction, manufacturing, and transport*  
*Models, salespersons, and demonstrators*  
*Sales and service elementary occupations* |
| High-offshorability | *High Paying occupations*  
*Physical, mathematical, and engineering professionals*  
*Other professionals*  
*Other associate professionals* | *Middling Occupations*  
*Stationary plant and related operators*  
*Office clerks*  
*Precision, handicraft, craft printing, and related trade workers*  
*Machine operators and assemblers*  
*Other craft and related trade workers* |
## Construction Jobs in UK

<table>
<thead>
<tr>
<th>Worker Employed in Construction in 2013</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>White Collar Jobs</td>
<td>22%</td>
</tr>
<tr>
<td>Executive &amp; Managerial</td>
<td>11%</td>
</tr>
<tr>
<td>Civil Mechanical Electrical Engineers</td>
<td>5%</td>
</tr>
<tr>
<td>Architects, town planners, surveyors</td>
<td>6%</td>
</tr>
<tr>
<td>Blue Collar Jobs</td>
<td>40%</td>
</tr>
<tr>
<td>Metal, electrical and mechanical trades</td>
<td>10%</td>
</tr>
<tr>
<td>Painters</td>
<td>3%</td>
</tr>
<tr>
<td>Bricklayers, masons, roofers, tilers</td>
<td>3%</td>
</tr>
<tr>
<td>Plumbers and heating and ventilating engineers</td>
<td>5%</td>
</tr>
<tr>
<td>Plasterers, glaziers and other trades</td>
<td>5%</td>
</tr>
<tr>
<td>Plant and machine operatives and drivers</td>
<td>7%</td>
</tr>
<tr>
<td>Carpenters and joiners</td>
<td>7%</td>
</tr>
<tr>
<td><strong>Other occupations</strong></td>
<td><strong>37%</strong></td>
</tr>
</tbody>
</table>
Workers, firms and consumer

Three factors that affect how employment reacts to automation.

- **Pool** of workers available that can supply complementary tasks
- Time it takes to acquire **skills** to supply complementary tasks
- Income **elasticity** of demand if the industry is competitive

**UK Construction Industry**

Shrinking **pool** of workers

Difficult to predict demand for which **skills** will survive automation and offshoring

Income **elasticity** of demand high, though property market unpredictable
**Learning: Heckman and Cunha**


- *Hierarchy* of skills acquisition
- *Dynamic complementarities* across time
  
  Early education has a much greater impact

- Designing a path to T-levels should start early
Research has established that people do not develop true understanding of a complex subject such as science by listening passively to explanations. True understanding comes only when students actively construct their own understanding via a process of mentally building on their prior thinking and knowledge through “effortful study”.

In addition to factual knowledge, experts have distinctive mental organisational structures and problem-solving skills that facilitate the effective retrieval and useful application of that factual knowledge. Experts also have important meta-cognitive abilities; they can evaluate and correct their own understandings and thinking processes. Developing these experts competencies, which go beyond the factual, is part of the student’s path to expertness.

Mega-projects


A mega-project is an extremely large-scale investment project. Megaprojects are typically defined as costing more than US$1 billion and attracting a lot of public attention because of substantial impacts on communities, environment, and budgets.

Megaprojects can also be defined as “initiatives that are physical, very expensive, and public” (Altshuler, 2003).

Care in the project development process may be needed to reduce any possible optimism bias and strategic misrepresentation.

The logic on which many of the typical mega-projects are built is on its collective benefits.

The most common mega-projects are in the categories of hydroelectric facilities, nuclear power plants and large public transportation projects.
BEYOND COST-BENEFIT ANALYSIS

The Rocking Millennium Bridge

Coordination, behaviour, multiple equilibria

Algorithms embedded (reasonable) assumptions

Known unknowns:

Rethinking cost-benefit analysis
PUBLIC AND PRIVATE CAPITAL INVESTMENT


- Marginal product of capital is very similar across the world


- Marginal product of public and private capital related through tax revenues
- Borrowing constraints for government and entrepreneurs related
- Multiple equilibria and coordination game between lenders
Frugal Innovation


Jugaad innovation:

Mars Orbiter Project.

Reality ($71M) cheaper than Fictionalised Reality ($100M)
Organisation of Mega-projects


O-ring production and the Challenger disaster:
complementarities between factors
perils of market

Diamond cutting industry:
high quality products that require initiative and innovation
require long term contracts

Scale and Competition

“Too many cooks spoil the broth” versus “Many hands make work light”
“We can know more than we can tell . . .”

– Polanyi (1966)