Is Additive Manufacturing an Upskilling or Deskilling Technology?  
Evidence from Job Vacancies

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Urtasun: Universidad Pública de Navarra
Taska: Burning Glass Technologies
Additive Manufacturing – AM

Traditional Manufacturing - TM

- No grinding, casting, molds, or assembly
- Short integrated process, design, materials
- Suitable for small scale decentralized production

US manufacturing job vacancies (managers, engineers, technicians, operators), 2014-19
Key questions

(1) Does AM raise or reduce skills requirements in comparison to TM?

(2) Does the effect of AM on tasks and skills vary across occupations?

We look for answer in employers’ job postings
Evidence from job postings 2014-19 from BGT firms

More than 3 million in 4 occupations

Focus on hybrid plants: 212,822 postings by 319 plants that posted at least 5 AM and 5 TM jobs each

<table>
<thead>
<tr>
<th>Occupation</th>
<th>AM jobs</th>
<th>TM jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managers</td>
<td>981</td>
<td>88,820</td>
</tr>
<tr>
<td>Engineers</td>
<td>2,678</td>
<td>77,975</td>
</tr>
<tr>
<td>Technicians</td>
<td>457</td>
<td>10,791</td>
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<tr>
<td>Operators</td>
<td>522</td>
<td>30,598</td>
</tr>
</tbody>
</table>

We analyze strings of terms extracted from job postings

Example of conversion of job posting to BGT terms

Machine Operator 1st shift

Operate Production Equipment
- Operate plastic extruder
- Install tooling and initiate fiber production when a line needs to be started
- Enter process information into production computer.
- Change consumable materials
- Operate material handling equipment
- Monitor all operational equipment, and ensure optimal standards are met

Maintain Tooling and Equipment
- Perform line upgrades and equipment maintenance as needed.
- Maintain a clean working environment at all times
- Troubleshoot issues with help of Engineering and Operations team members

Transfer Consumable Materials from Inventory to Production
- Prepare materials for production.
- Transfer materials to inventory
- Notify Team Leader if/when any material issues are observed

Support in Special Projects
- As needed, projects to be determined

Qualifications and Experience
- Minimum education: High school
- Preferred education: 2-year degree in electronics or other technical fields
- 5 years of experience in manufacturing-related field
- Experience with Safety systems
- Familiarity with additive manufacturing (preferred)
- Experience working with fiber material (preferred)
- Experience working with plastic material (preferred)

Specialized knowledge in the following
- Automated manufacturing equipment
- Electronics
- Vacuum ovens (preferred)

Skills and Certifications
- Microsoft Office Suite
- Google Documents
- Verbal/written communication
- Organized
- ERP/MRP (preferred)
- QMS (preferred)

In addition, BGT provides Job Date, SOC, Employer, NAICS, Latitude, Longitude, Education, Experience, Salary, and Certifications. These are not included in the string illustrated above, but we use them in our analyses described in the text.
### Measures of skills

<table>
<thead>
<tr>
<th>Primary activities</th>
<th>Advanced activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic activities</td>
<td>High level</td>
</tr>
<tr>
<td>Elementary</td>
<td>Design</td>
</tr>
<tr>
<td>Technical support</td>
<td>Specialized software</td>
</tr>
<tr>
<td>Support activities</td>
<td>Business &amp; finance</td>
</tr>
<tr>
<td></td>
<td>Office software</td>
</tr>
</tbody>
</table>

#### Task attributes
- Complexity
- Nonroutine analytic
- Routine manual

#### General skills
- Character
- Cognitive skills
- Social skills

### 1. AM is upskilling if
- \( >1 \) measure
- And 0
- Else: weights
- Some more important

### Measure of skill
Count of terms in posting that match keywords that correspond to a task or skill

**Complexity:** advanced, analy, change, creativ, design, develop, devising, evaluate, experiment, improve, initiative, interpret, learn, model, multi-tasking, plan, project, research, simulat, sketch. Keywords that are subtracted: order, procedure, protocol, repetitive, rule, standard.

### 2. AM is skill biased if
\[ \Delta \text{ engineer } > \Delta \text{ operator} \]

\[ \Delta = \frac{\text{Skill(AM)} - \text{Skill(TM)}}{\text{Skill(TM)}} \]

### Findings
1. AM is upskilling in most skills and tasks
2. AM is mildly reverse skill-biased (closing a bit of the skill gap)
3. Skill difference declining over time

Next: A brief look at predictive margins from

\[ y_{jpo} = \alpha + \beta AMTM_j + \gamma Quarter_j + \lambda AMTM_j \times Quarter_j + \eta_p + \nu_o + \varepsilon_{jpo} \]

(1) most estimates on technology AMTM > 0,
(2) \( \Delta \) Operators > \( \Delta \) Engineers, Managers for important skills
(3) Change over time – decline for several measures, but not to 0

Measures of skills

**Primary activities**

- Basic activities
  1. Elementary
  2. Technical support
- Advanced activities
  3. High level
  4. Design
  5. Specialized software
- Support activities
  6. Business & finance
  7. Office software

**Task attributes**

- 8. Complexity
- 9. Nonroutine analytic
- 10. Routine manual

**General skills**

- 11. Character
- 12. Cognitive skills
- 13. Social skills

Predictive margins at quarter 12, normalized measures by TM mean, hybrids
Thank You
**Within-Occupation and Within-Plant Matched-Pair Means**

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<thead>
<tr>
<th>Basic activities</th>
<th>Elementary</th>
<th>Inventory</th>
<th>Production</th>
<th>Tooling and Machining</th>
<th>Technical Support1</th>
<th>Technical Support2</th>
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<td>0.5</td>
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<td>0.3</td>
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<thead>
<tr>
<th>Advanced activities</th>
<th>High Level</th>
<th>Materials Science</th>
<th>Product Development</th>
<th>Science &amp; Research</th>
<th>Design</th>
<th>Specialized Software</th>
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<th>Customer Service2</th>
<th>Data Analysis1</th>
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<th>Finance</th>
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