

# **Is Additive Manufacturing an Upskilling or Deskilling Technology?**

## **Evidence from Job Vacancies**

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# Additive Manufacturing – AM Traditional Manufacturing - TM

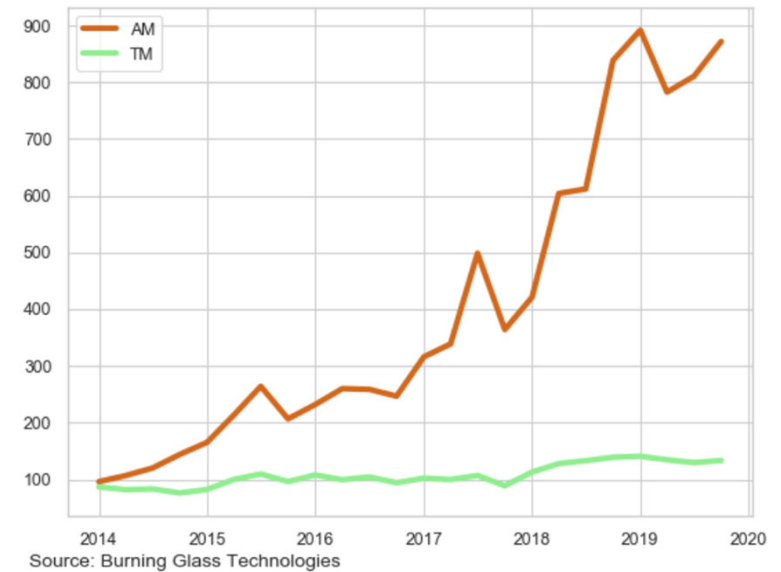
No grinding, casting, molds, or assembly

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

Occupation	AM jobs	TM jobs
Managers	981	88,820
Engineers	2,678	77,975
Technicians	457	10,791
Operators	522	30,598

We analyze **strings of terms** extracted from job postings

Electronics Industry Knowledge, Manufacturing Resource Planning (MRP), Enterprise Resource Planning (ERP), Equipment Maintenance, Troubleshooting, Lean Manufacturing, Written Communication, Microsoft Office, Project Management, 3D Printing / Additive Manufacturing (AM), Machine Operation, Material Handling Equipment, Leadership, Organizational Skills.

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

## Example of conversion of job posting to BGT terms

### Machine Operator 1<sup>st</sup> 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 materials (preferred)
- Experience working with plastic (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)

## Measures of skills

### Primary activities

Basic activities

Elementary

Technical support

Advanced activities

High level

Design

Specialized software

### Support activities

Business & finance

Office software

### 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

### 2. AM is skill biased if

$\Delta$  engineer >  $\Delta$  operator

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

## 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.

Autor, Levy Murnane QJE 2003. Spitz-Oener JoLE 2006, Deming & Kahn JoLE 2018, Hershbein & Kahn AER 2018 Deming & Noray QJE forth, Atalay et al. AEJ-Applied 2020

## 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

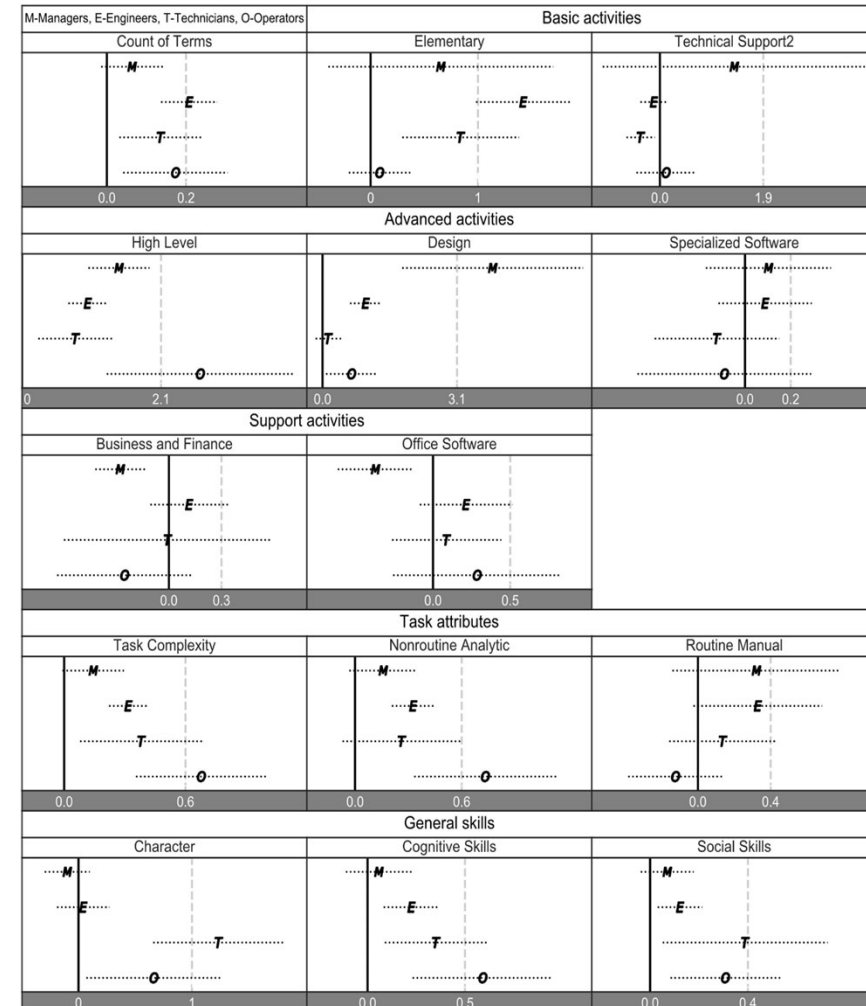
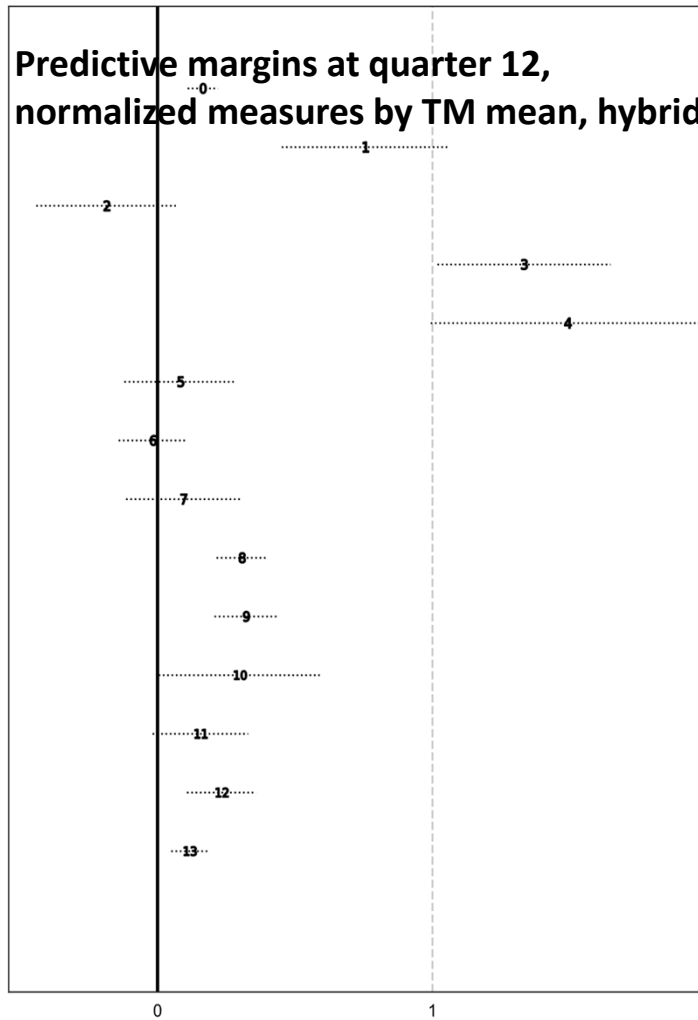
### General skills

11. Character

12. Cognitive skills

13. Social skills

## Predictive margins at quarter 12, normalized measures by TM mean, hybrids



## Predictive margins 24 quarters (2014-19) normalized measures by TM mean, hybrids

### Primary activities

#### Basic activities

1. Elementary

2. Technical support

#### Advanced activities

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### Support activities

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### Task attributes

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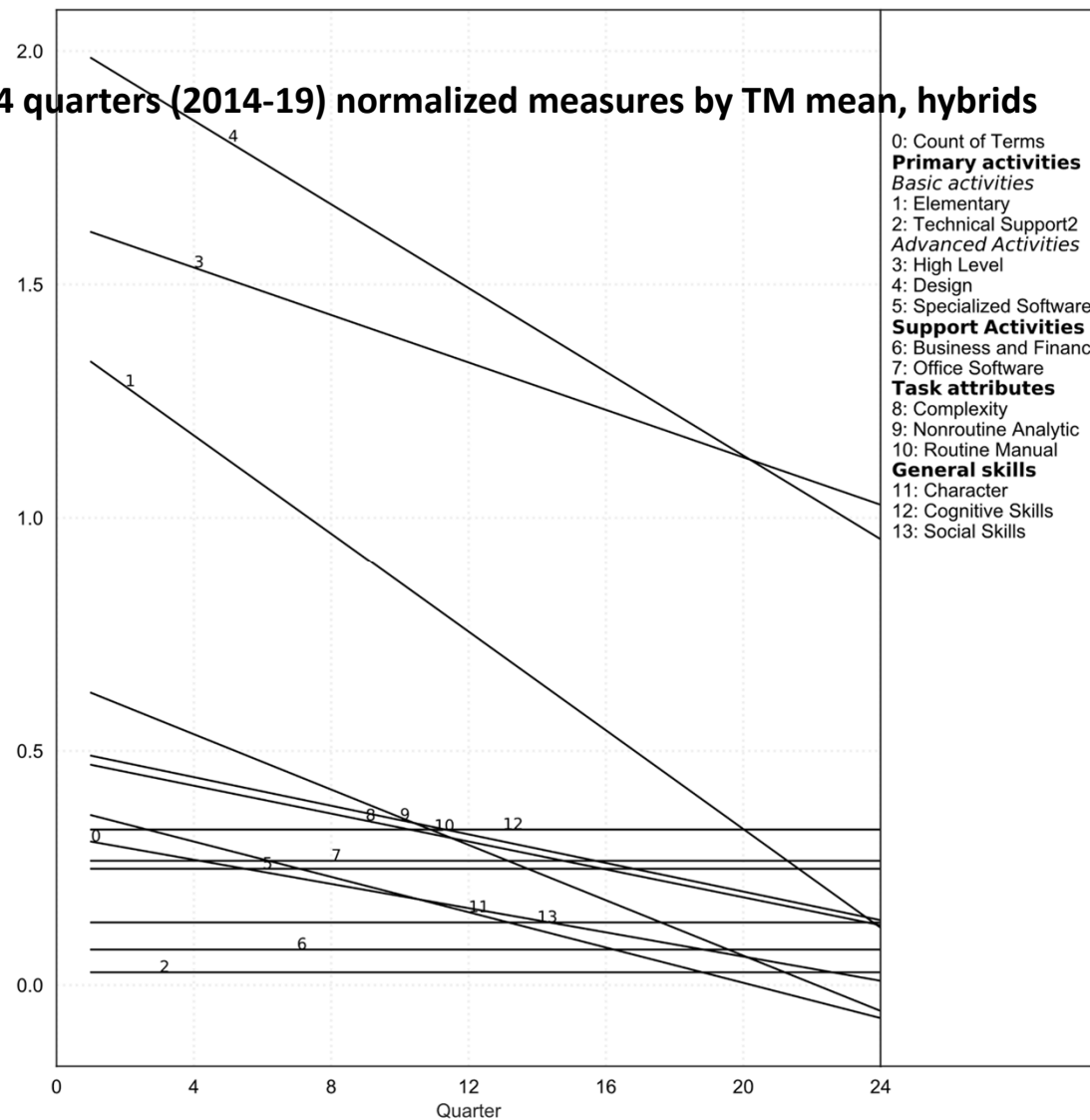
10. Routine manual

### General skills

11. Character

12. Cognitive skills

13. Social skills



תודה  
Dankie Gracias  
Спасибо شُكراً  
Merci Takk  
Köszönjük Terima kasih  
Grazie Dziękujemy Dékojame  
Ďakujeme Vielen Dank Paldies  
Kiitos Täname teid 谢谢  
**Thank You** Tak  
感謝您 Obrigado Teşekkür Ederiz  
Σας Ευχαριστούμ 감사합니다  
ඔබටතෙත  
Bedankt Děkuje vám  
ありがとうございます  
Tack



## .ithin-occupation and within-plant matched-pair means

