Social Implications

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Motivation

Technology is socially embedded

Whether NM-ICs become a hit depends on more than their functions and performance!

By the time they hit the market it may be too late to correct course on some social problems

To increase our chances of success we need to get a head start on identifying their:

Economic, privacy, ethical, legal, sustainability implications

That may directly inform technical design as well as shape the other human practices that carry this technology into the market.

Motivating question: what are those implications likely to be?

Approach

Scholars talk about these implications in the literature…

Basic challenge:

- there is a lot of literature (in general)

- there is very little literature on the social dimensions of NM-ICs because the technology is so nascent

Lets look at a related set of technologies—3D printing / additive manufacturing—that are similar to NM-ICs in some important ways (low cost, distributed, on-demand, customized production) But have been on the market for a while generating social implications.

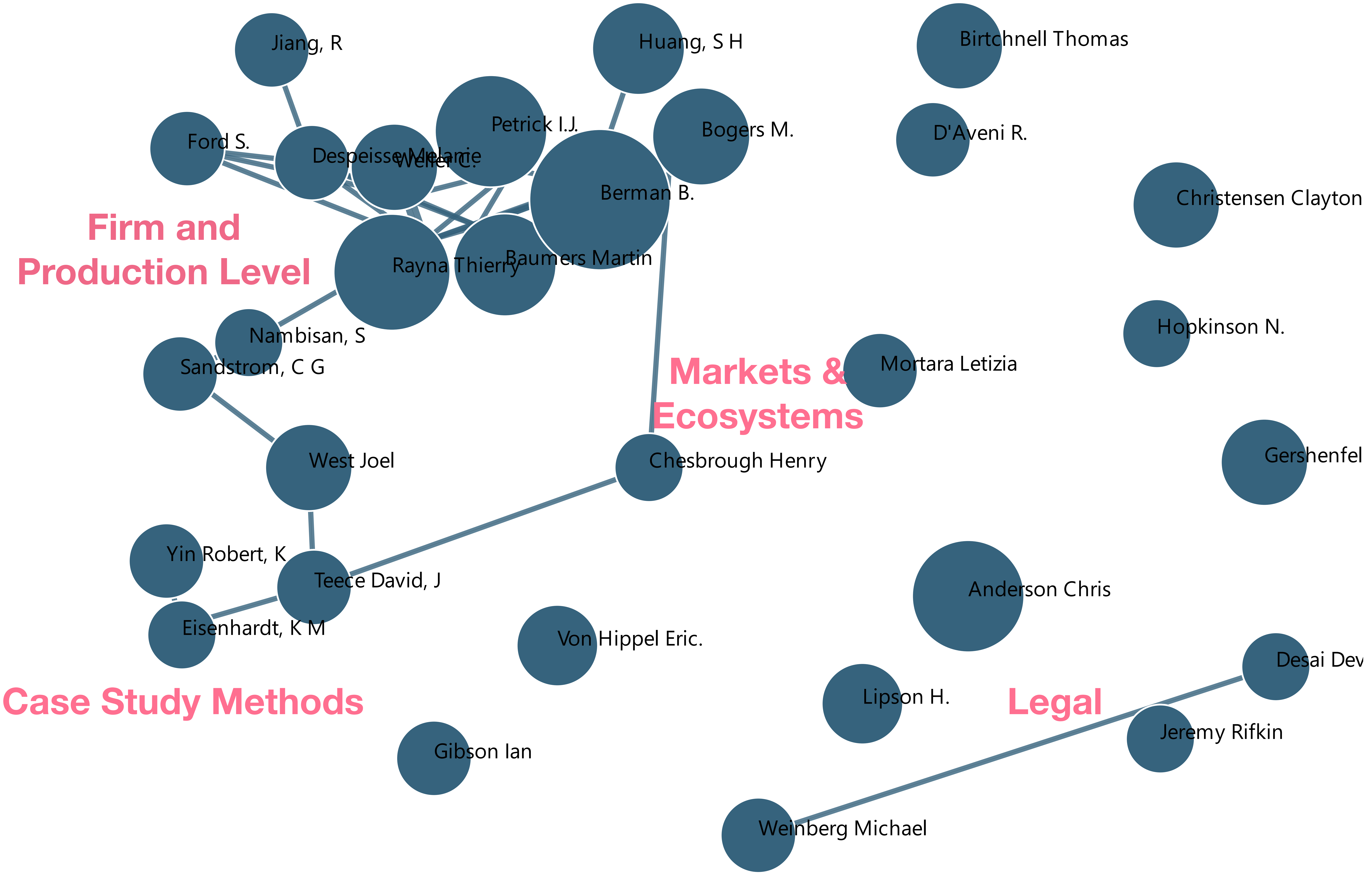
Data and Methods

Web of Science: Metadata for tens of millions of scientific journal articles

- We pull any document that mentions additive manufacturing or 3D-Printing (including many name variants)
- That was published in a social science or humanities journal
    - **Returns 1,009 Papers**

We want to get a low-dimensional perspective of the topics that are most salient to authors in this literature.

A natural way to do that is to look at the literature that authors discussing the social implications of AM / 3D Printing cite to frame their work and back up their claims.



Firm and Production Level
Markets & Ecosystems
Case Study Methods
Legal
Jiang, R
Huang, S H
Birtchnell Thomas
Ford S.
Petrick I.J.
Bogers M.
D'Aveni R.
Despeisse Melanie
Weller C.
Berman B.
Christensen Clayton
Rayna Thierry
Baumers Martin
Hopkinson N.
Nambisan, S
Sandstrom, C G
Mortara Letizia
West Joel
Chesbrough Henry
Gershenfel
Yin Robert, K
Teece David, J
Anderson Chris
Eisenhardt, K M
Von Hippel Eric.
Desai Dev
Lipson H.
Jeremy Rifkin
Gibson Ian
Weinberg Michael

Firm / Production Level

Materials and Process Improvement

1. Can you raise material properties to/beyond the quality used in traditional manufacturing? (Hopkinson and Dickens, 2001; Thompson et al. 2016; Campbell et al. 2012)
2. Local benchmarks for designs/products (Thompson et al. 2016)
3. Local and global (i.e. across fleets of machines) feedback to create continuous beta Jiang et al. 2017)
4. for you raise material properties to/beyond the quality used in traditional manufacturing? (Thompson et al. 2016; Campbell et al. 2012)

Costs

1. Simplified supply chains by decentralizing and integrating fabrication, locating it near user / point of sale Baumers et al. 2016
2. Less material + waste required per output Huang et al. 2013
3. Increases in cost from non-standard materials, poor tolerances, need for post-processing Baumers et al. 2016

Market and Ecosystem Level

Openness *(Useful knowledge rests beyond boundaries of a single firm)*

1. Source new applications and prototype features from users (von Hippel, 1986; Von Hippel and Katz 2002… *lots of other von Hippel papers*.)
    1. Virtual user environments may help facilitate that (Nambisan and Barron, 2009)
2. Efficient contracts and markets for intellectual property (Chesbrough, 2003)
    1. i.e. to brand and share digital design files (Jiang et al. 2017)

New Entrants

2. May lower barriers for market entry (Weller et al. 2015)
3. New entrants more likely to succeed by addressing bottom of / new markets Christensen, 1997
    1. Customization opens up value in new markets where individualized products v.important but expensive (e.g. healthcare) (Huang et al. 2013)
4. Economies of scale remain: local user facilities may be important in reducing barriers to entry (Baumers et al. 2016)

6. Unclear whether additive manufacturing has disrupted business models so far; likely continue to see it coexist with traditional manufacturing (Rayna and Striukova, 2016)

Sustainability

Circular Economy

1. Basic principle: use waste + old products as inputs for new products
2. Barriers to realizing those principles: design, supply chains, information flows, entrepreneurship, business models and education (Despeisse et al. 2017; Despeisse and Ford, 2015)
3. Need to account for total lifecycle energy and material consumption (Ford and Despeisse, 2016)

Intellectual Property

Key problems are appropriability and market entry

1. Concerns in 3D-P / AM that increase in value creation (from customizability, cost) offset by difficulty in appropriating that value. (Rayna and Striukova, 2016)

2. Patents may not be very effective—difficult to identify and litigate against infringers w/ digital files and decentralized production Desai and Magliocca 2013

User end

3. As with regular printers, producers can capture surplus by locking consumers into proprietary materials (e.g. ink)

4. 2015 ruling from copyright office killed this for 3D printers Weinberg, 2018

Less emphasis on other topics

We do not have comprehensive data, we may have missed some areas of the literature. But there are some noticeable omissions

1. Ethical considerations revolve around access to the technology itself rather than misuse (notable exception from news: people 3D printing weapons at home)
2. Privacy concerns effectively absent from the literature we see

Wrapping Up + Next Steps

1. Finalize slides and send comprehensive bibliography (incl. stuff not on slides)
2. Collaborate / provide input on other aspects of project

Thank You!
Questions?