Online Labor Platforms and the Future of Engineering Design Work

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Problem Description

It is assumed that engineering design work cannot be easily outsourced and distributed. The **expertise**, **coordination** and **communication** associated with the design process makes it difficult to remove this work from the firm.

The rapid advancement of digital infrastructure that enables firms to directly interact with a global workforce on an as-needed, task basis through **online labor platforms** now allows efficient outsourcing of individual, high-expertise tasks.

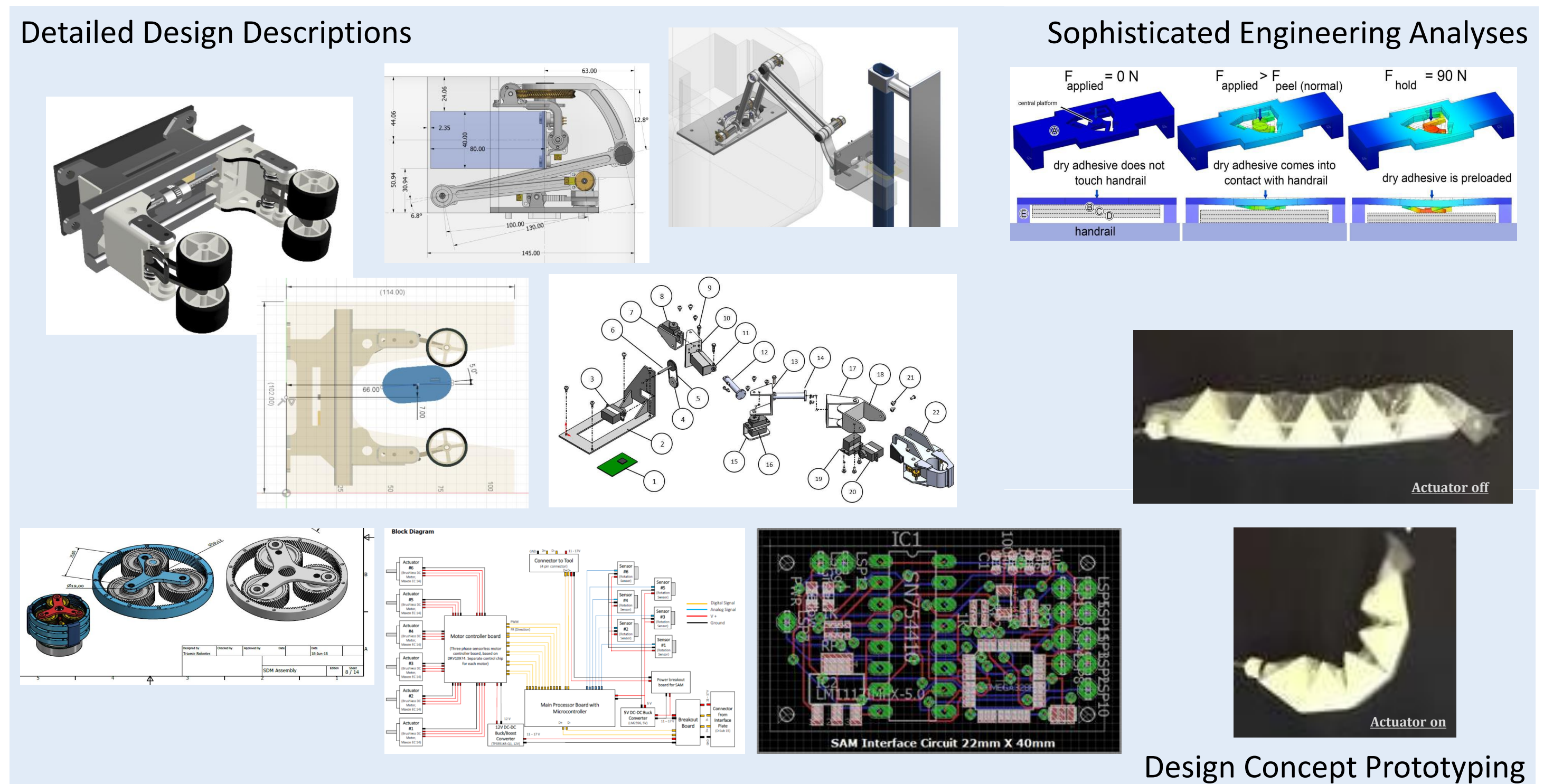It is unclear now whether this type of intellectual work will remain protected.

Current Paradigm — "in-house"
Future Paradigm
"out-of-house"

freelancer / Upwork / amazon mechanical turk / fiverr

Data sources:
"Independent Contractors and the Emerging Gig Economy." Accessed June 15, 2019. https://www.americanactionforum.org/research.
"Global Coworking Growth Study | Forecast and Statistics 2019." Accessed June 15, 2019. https://www.coworkingresources.org/blog/key-figures-coworking-growth.

Previous Work, Research Questions

Focus on Policy and Regulation of low-skill tasks
Online labor platforms have been dominated by industries utilizing low-skill labor. Majority of research has focused policy and legal issues, with an industry perspective. [1,2]

Research Questions:
- Can good quality engineering design work be accomplished through open online labor platforms?
- Who is doing this kind of intellectual work through online labor platforms?

[1] Burtch, Gordon, Seth Carnahan, and Brad N. Greenwood. "Can You Gig It? An Empirical Examination of the Gig Economy and Entrepreneurial Activity." Management Science 64, no. 12 (2018): 5497–5520.
[2] Kuhn, Kristine M. "The Rise of the 'Gig Economy' and Implications for Understanding Work and Workers." Industrial and Organizational Psychology 9, no. 1 (March 2016): 157–62.

Method

Experimental Study: Developed and ran a series of 17 engineering design contests requiring varying levels of complexity/size and interdisciplinarity on an online digital platform, Freelancer.com
- Each contest was related to the design of an autonomous robotic manipulator to be used in space
- Considered 10 individual contests where the task was either to design a full robotic system or to design a key subsystem or component.

Freelancer.com: > 33 M users > 15 M tasks

NASA — ASTROBEE CHALLENGE SERIES — Can you design something out of this world?

Data: In addition to **Design Submissions** for each contest, we collected information from active members of the online platform community:
- before exposure to contest details through a **Registration Survey**,
- during the contest through platform-hosted user forums and **interest tracking data**, and
- For every design solution submitted through an **Exit Survey**

Registration Survey
11,658 *registered* Freelancers

User Tracking & Forum Data
6190 *interested* Freelancers

PAST NASA CHALLENGES — ASTROBEE CHALLENGES — COMPLETED
NASA is designing a next generation robotic assistant to support astronauts on the International Space Station (ISS).
- PRIZE $1500 — "Smart" Attachment Mechanism — Design a "Smart" Attachment Mechanism
- PRIZE $4000 — "Smart" Positioning and Attachment Mechanism — Design a "Smart" Positioning and Attachment Mechanism
- PRIZE $500 — Attachment Mechanism — Design an Attachment Mechanism
- PRIZE $250 — Simple Deployment Mechanism — Design a Simple Deployment Mechanism

Exit Survey — 174 **submissions** — 10 **contests**

Design Submission — 95 *"good"* submissions — 63 **people**

Detailed Design Descriptions

Sophisticated Engineering Analyses

Actuator off / Actuator on

Design Concept Prototyping

Analyses:
- Quantitative analysis of participants' demographic and work history data using Registration and Exit Survey data.
- Qualitative coding of Design Submissions for quality of work product and design process.
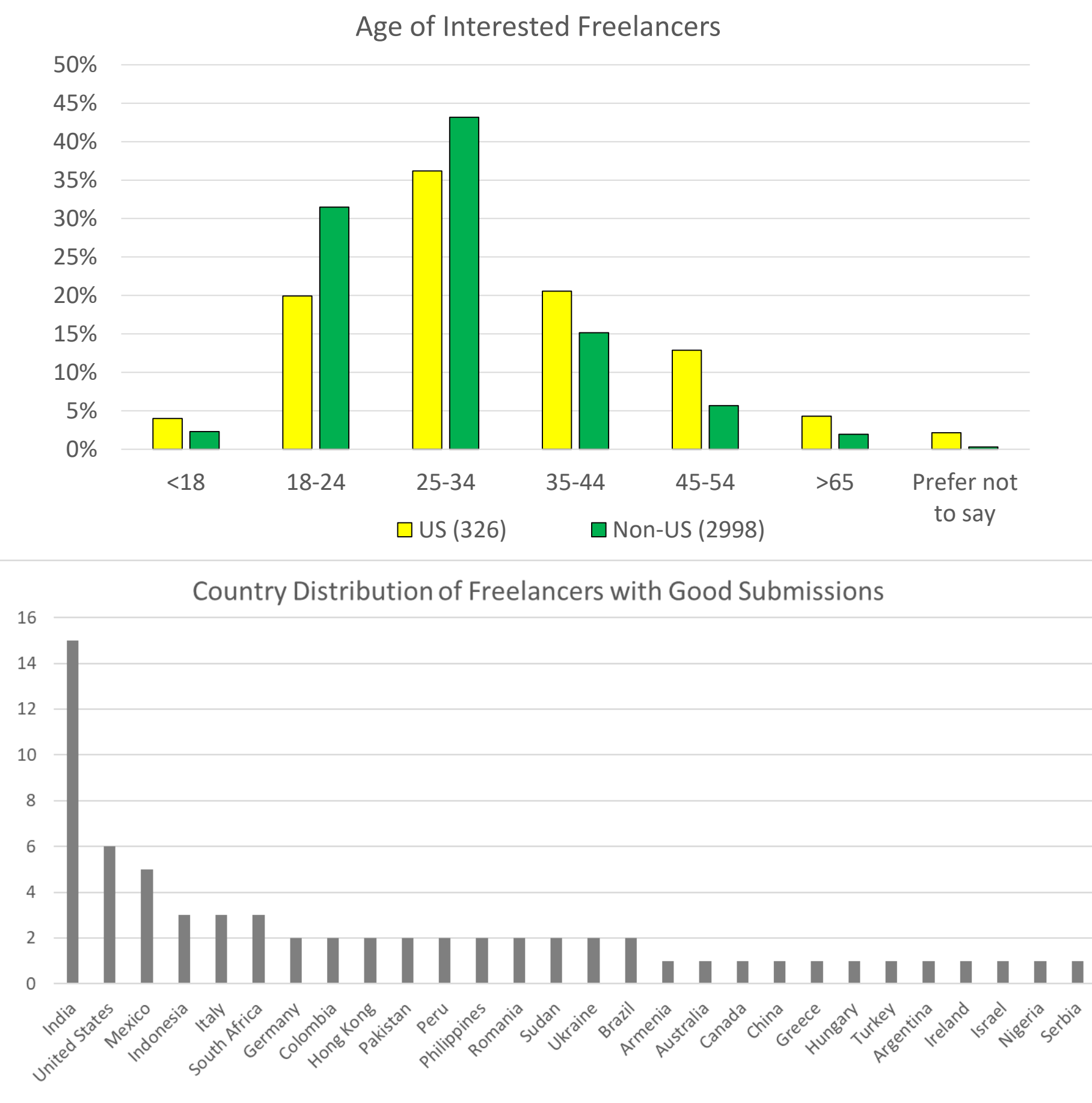
Preliminary Results

(1) Capable workforce, with appropriate expertise for engineering design work, found to be available through online labor platform
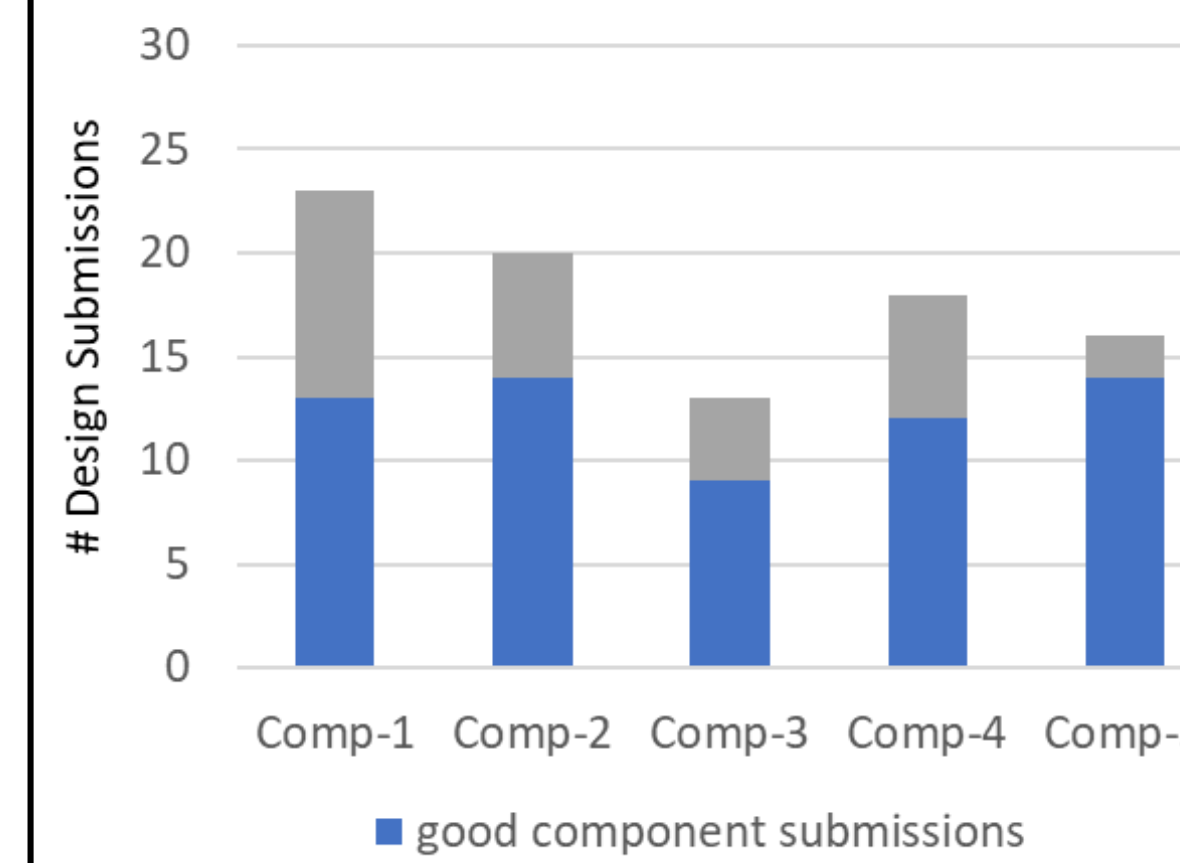- Accessing workers with similar work experience as "in-house" designers
- More US participation than expected – even with lower pecuniary incentives
- Age distribution for US freelancers similar to non-US population – not dominated by younger & retired workers

(2) Good solutions and useful design work generated for all tasks
- However, capability and accessibility not uniform across tasks of differing complexity
- Higher yield of good design submissions for Component-level tasks
- System-level design submissions had higher variability in quality – uncertainty in access to workers capable full system design
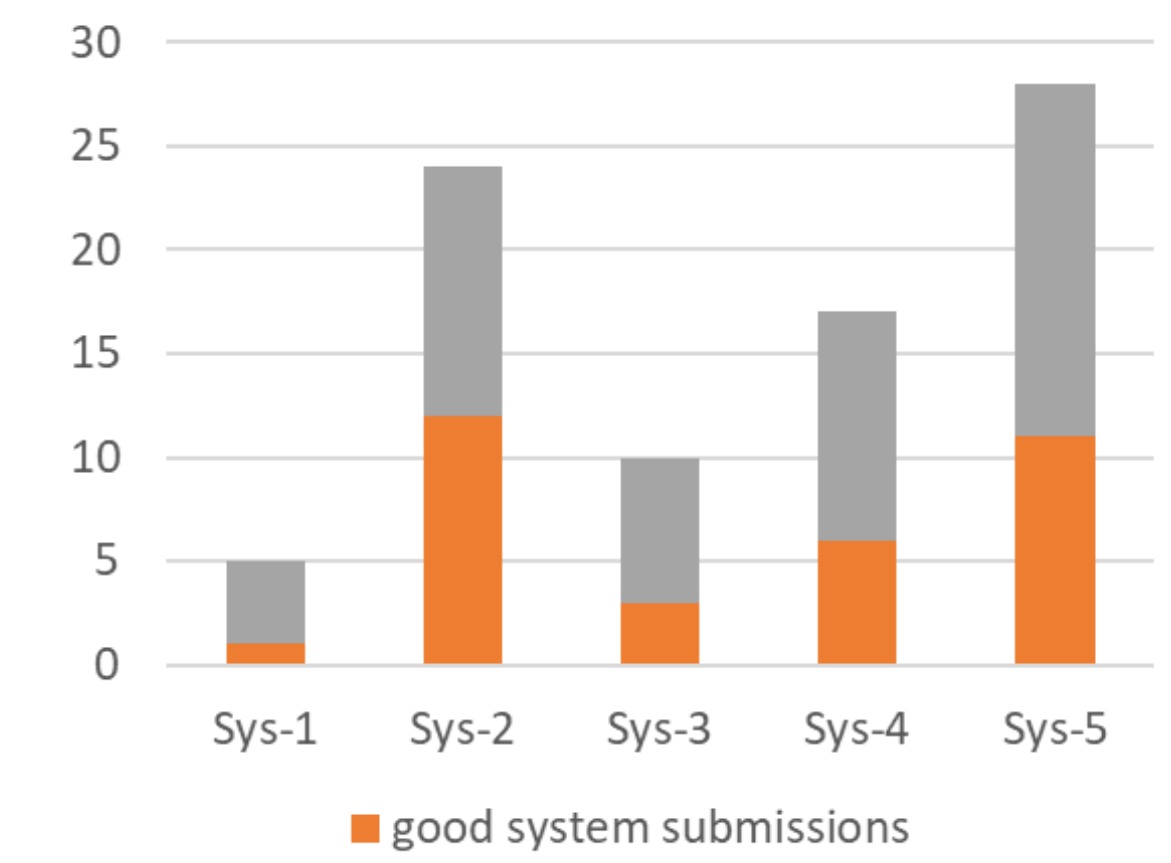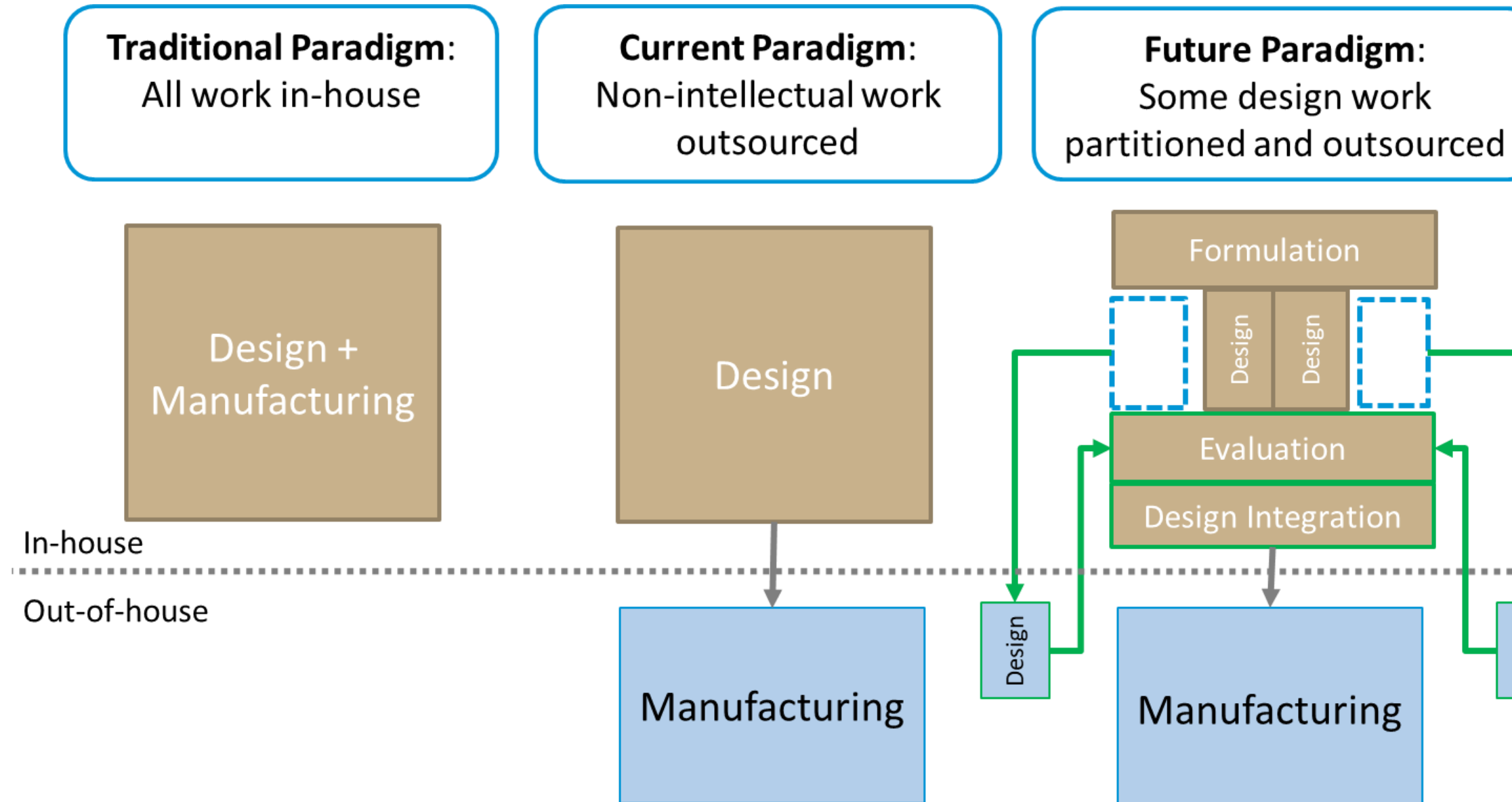- More effort needed to evaluate System-level design submissions for usability

Age of Interested Freelancers
US (326) / Non-US (2998)

Country Distribution of Freelancers with Good Submissions

Component Design Tasks
Comp-1, Comp-2, Comp-3, Comp-4, Comp-5
good component submissions
- 1283 interested people
- 90 submissions
- **62 good from 41 people**

System Design Tasks
Sys-1, Sys-2, Sys-3, Sys-4, Sys-5
good system submissions
- 2773 interested people
- 84 submissions
- **33 good from 22 people**

Future Work

Traditional Paradigm: All work in-house
Current Paradigm: Non-intellectual work outsourced
Future Paradigm: Some design work partitioned and outsourced

Design + Manufacturing / Design / Formulation / Evaluation / Design Integration / Manufacturing

In-house / Out-of-house

- Qualitative analysis of Submissions across contests to better understand the design process with the goal of informing decomposition and distribution strategies to efficiently produce good integrated solutions
- Examine additional coordination costs for partitioning Design to make use of remote design workers, particularly additional design evaluation and design integration activities

Acknowledgements