Network Formation in Peer-to-Peer Additive Manufacturing

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In this paper we look at the formation and dynamics of peer-to-peer networks in additive manufacturing through a game-theoretic approach. We develop a non-cooperative model to analyze the interactions between manufacturers and customers in distributed 3D printing networks across multiple geographical locations. We focus on community-based manufacturing networks where individual service providers cater to multiple customers while managing capacity constraints and quality requirements. The model incorporates several key decision parameters that influence network formation. From the customer perspective, these include quality preferences and time sensitivity in selecting 3D printing services. From the manufacturer side, we consider capacity utilization, distinguishing between providers with excess capacity and those with surplus orders. The model also accounts for inter-manufacturer collaborations and direct customer sales in determining revenue streams. Through simulations, we evaluate various scenarios with different combinations of customer types and manufacturer capacities. Our analysis reveals conditions for pairwise stability and efficiency of these networks. The results demonstrate how factors such as quality preferences, delivery time constraints, and capacity limitations influence network formation. The findings tell us about the formation of additive manufacturing networks, contributing to our understanding of how peer-to-peer manufacturing systems can effectively operate at scale. Our findings suggest strategies for balancing customer requirements with manufacturer capabilities, while maintaining network stability and efficiency.