Toward Manufacturing-as-a-Service (MaaS) in Local Realities of Production: the italian Case of Janus 5.0 and the Role of Design

Caterina Dastoli [1], Gabriele Goretti [1], Massimo Biribicchi [2], Lorenzo Masini [3]

[1]*DESTEC Department, University of Pisa*

[2]*BRT Consulting s.r.l.*

[3]*Supermateria*

Abstract

Cloud Manufacturing constitutes an advanced production paradigm that facilitates manufacturers' integration into an interconnected ecosystem of shared resources through collaborative manufacturing platforms. While such platforms have been extensively adopted by multinational corporations operating on a global scale, their implementation remains limited within smaller, localized production systems—particularly in Italy. While the country's manufacturing sector is deeply rooted in a long-standing tradition of developing innovative products within regional networks of highly specialized expertise, small and medium-sized enterprises (SMEs) embedded in these territorial models often lack a comprehensive, system-oriented approach to manufacturing, despite they operate throughout the complexity of a global value chain. In this context, Design research is expanding its strategic scope, positioning Design as a fundamental organizational capability in the co-creation of manufacturing ecosystems. As an integrative discipline, Design facilitates the mobilization and transformation of resources to optimize production processes and strategic outcomes. This paper positions the role of Design within the specific framework of Italy's localized manufacturing landscape, emphasizing its implications for the implementation of platform-based manufacturing models. Specifically, this study explores the case of *Janus 5.0*, a novel collaborative manufacturing platform aimed at enhancing new product development within small metalworking enterprises in the Tuscany region. Through a qualitative approach that involves the platform's co-founder, this research identifies key barriers to adopting platform-based manufacturing within unbranded manufacturing firms, investigates the perceived value of Design in these contexts, and discusses the broader strategic potential of Design as a competitive capability in organizational development.

Keywords

Design capability; Industry platforms; Manufacturing-as-a-Service; Industrial districts; Italian SMEs

1. Introduction

Since the 1980s, companies have implemented various production models aligned with the prevailing technological paradigm, striving to enhance flexibility as a core capability. Among these models, Cloud Manufacturing (CM) stands out due to its extensive ability to integrate diverse resources. This model enables the aggregation of distributed manufacturing resources and capabilities and provides on-demand network access to configurable manufacturing services that can be quickly provisioned and released without significant management effort (Liu et al., 2019). Through this approach, CM allows firms within the production system to access a network of manufacturing resources, facilitating their overall success.
Particularly, this model enables companies to utilize a digital platform for on-demand access to a collective pool of manufacturing services, broadening their traditional offerings by integrating various service-based solutions. This transformation, commonly referred to as the servitization of manufacturing or Manufacturing-as-a-Service (MaaS), is reshaping the competitive landscape of the manufacturing sector.

Although MaaS has gained widespread adoption among large multinational corporations, its integration within localized production systems remains limited. This is particularly evident in Italy, a country with a well-established manufacturing tradition, where companies typically develop new products within specialized local networks. Italian small and medium-sized enterprises (SMEs) often lack a comprehensive, system-wide approach to manufacturing, despite having the potential to benefit from the agility and adaptability that platform-based solutions provide. Furthermore, the production system of these SMEs draws on a global value chain,

supplying major brands that depend on SMEs cost efficiency and short production cycles (Fry et al., 2017). Therefore, entering the manufacturing ecosystem through the adoption of manufacturing platforms represents a crucial advancement for italian SMEs toward the optimization of production dynamics.

In this framework, Design can play a pivotal role in facilitating the adoption of platform-based manufacturing by helping to establish mutual credibility for platform providers and participants entering the network through the development of evidence-based initiatives. For instance, Schrage (2014) highlights the importance of prototyping in creating a "shared space" where various partners can collaboratively prototype, enabling customers to contribute to the innovation infrastructure (Schrage, 2014, p. 56).
This aspect of Design, which directs the co-creation of ecosystems composed of interacting manufacturers and industry stakeholders, is gaining increasing attention in contemporary research (Dastoli, 2022; Dastoli et al., 2021). From this perspective, Design emerges as a vital organizational resource, helping manufacturers effectively mobilize and reconfigure resources to achieve specific goals. Indeed, while the role of Design in fostering competitive advantage for businesses is widely recognized, some studies also underscore the crucial function of designers in enhancing a company's organizational design capabilities. Cautela et al. (2021) explored the dynamic capabilities of Design within Italian firms, emphasizing that Design's impact extends beyond the role of ideation. Indeed, the ideation ability may often be outsourced to external creative communities (e.g., crowdsourcing platforms, design competitions, hackathons, or design jams) rather than being solely managed by the firm's in-house designers. Consequently, designers in Italian SMEs often function as facilitators, leveraging the ideas of others and translating them into product requirements, rather than generating entirely new concepts (Bertola & Teixeira, 2003). As a result, Design can occupy an organizational role that helps companies adapt to, drive, and shape change, transcending the ideation phase (Rindova & Courtney, 2020).

This paper explore the role of Design within the particular context of local production systems in Italy, with a focus on the implementation of platform-based manufacturing. Specifically, it investigates the case of Janus 5.0, an innovative manufacturing platform designed to optimize new product development for small metalworking firms in the Tuscany region. Through data collection and interviews with the co-founder of Janus 5.0, the paper collect insights about the challenges of implementing platform-based manufacturing in unbranded companies, the perceived role of Design within these contexts, and the potential for Design to establish itself as a competitive strategic capability for organizational design.

2. Background

2.1 Manufacturing in Italian Industrial Districts and the Need for ICT

Manufacturing exhibits a longstanding tradition of structuring NPD through networks of specialized expertise, namely industrial districts (Becattini, 2002). These territorial models consistently yield positive outcomes, including the promotion of innovation, entrepreneurial initiatives, economic competitiveness, sustained growth, and long-term industry success (Scaringella & Radziwon, 2018). Therefore, through the active participation in local industrial interactions, manufacturing firms enhance economies of scale by developing high-performance production systems. However, manufacturers in industrial districts collaborate and compete toward the efficiency of the industry they belong to. This can lead to the stability of the industrial system that can result in significant challenges for companies in creating long-term value (Geels, 2004), particularly considering technological disruptions of our times. Indeed, the rapid pace of technological progress can outstrip the capacity of industrial systems to adapt, leading to shifts in consumption patterns that occur prior to corresponding adjustments in manufacturing (Porter & Kramer, 2011; Whitney, 2015).

Consequently, italian manufacturers are currently facing the challenge to meet the flexibility demands of the digital revolution. For this purpose, manufacturers in industrial districts are more and more integrating computational capabilities inherent to Information and Communication Technologies (ICT) to advance the notion of the "extended product," that integrates services and embedded technologies to the physical product (Camarinha-Matos et al., 2009; Porter & Heppelmann, 2014). When manufacturers integrate ICT for the development of differentiated offerings, they start leveraging the combinatory potential of products and services. As a result, the locus of competitive differentiation shifts from design innovation to manufacturing efficiency, and subsequently from product innovation to process innovation (Schilling, 2010). Indeed, extended products open up a new competititve panorama for new product development since strategic competition moves from the production stage to the pre- and post-production phases of new product development (NPD) (Roos, 2014). Therefore, manufacturers that adopt ICT are aware that physical fabrication represents only a fraction of of the

overal manufacturing process to compete and success in current times of change. Particularly, in the contemporary technological landscape, the computational affordances (Neff et al., 2012) of ICT present manufacturing firms with the opportunity to develop expansive systems of solutions, thereby blurring traditional industrial boundaries. ICT can thus extend the operational scope of manufacturers, which can potentially structure collaboration among a distributed panorama of heterogeneous expertise to expand their area of intervention. By leveraging actionable properties of ICT (Kelly, 2010), manufacturing firms in italian industrial districts can participate to the contemporary rules of competition that define the prioritization of knowledge acquisition and utilization as a core asset (OECD, 1996).

2.2 Platform-based Manufacturing

Gawer and Cusumano (2014) deepen this perspective on competition to the industrial domain through the conceptualization of industry platforms. Industry platforms are strongly linked to the concept of "infrastructures" (Karasti, 2014), and represent the foundational enablers for a number of firms to create complemetary offerings and benefit from network effects. Therefore, companies that join industry platforms have access to a larger knowledge depository (Roundy, 2020) that facilitate combinatorial innovation of products and services. While industry platforms encopass a number of industrial sectors, manufacturing can benefit from ICT infrastructures that support the connections between the physical and the cyber components of the industrial systems (Terkaj et al., 2015). Particularly, the application of Cloud Manufacturing (CM) to digital platforms enables the virtualization of both hardware and software resources and capabilities and consolidate them within a cloud system. By allowing participating manufacturers to access, integrate and share production services among various stakeholders (Helo et al., 2021), CM exploit the potential of on-demand production, that includes the optimization of customized B2B and/or B2C offerings through the leverage of heterogeneous and distributed manufacturing resources.

If manufacturing platforms represent a valuable means for manufacturers, they also open up a new intervention space for platforms providers who can enterprise new business models to facilitate the combination of products and services (Kusiak, 2019). Since manufacturing platforms play a pivotal role in reducing production costs and times while addressing the critical need for manufacturing flexibility, they attract a critical mass of manufacturing firms who pay for gaining access to shared manufacturing resources and capabilities (Tolio et al., 2023). As a consequence, manufacturing platforms are emerging rapidly, and their scope and architecture can be designed for dedicated manufacturing purposes.

Manufacturing platforms have the characteristics of integrating geographically dispersed manufacturing systems, allowing them to operate from multiple locations while serving a global market (Barenji et al., 2021). This aspect represents a crucial opportunity for italian manufacturers to optimize production at the level of the global value chain they constantly interface with. Particularly, platforms providers start covering a pivotal role in enabling competitive success of italian manufacturers, since they can design organizational strategies that support decision making when new production directions need to be taken.

2.3 Design for Platform-based Manufacturing

From this perspective, NPD goes beyond the mere creation of physical products and services. In the field of design, Buchanan (2004) views NPD as a strategic approach aimed at creating innovative pathways for interaction. In the context of MaaS, NPD becomes a key organizational capability that enables companies to identify product opportunities by utilizing valuable knowledge. When NPD is employed as a framework for recognizing and implementing new product opportunities, it evolves into a process focused on fostering relationships. When treated as an organizational function, Junginger (2008) argues that design reaches its full potential when it facilitates the participation of human capital in the development of new products. By positioning human capital as the primary driver of exploration and innovation, design becomes a tool for harnessing collective expertise to propel product development. Buchanan (2015) supports this idea, asserting that the purpose of a company is to provide goods and services to society. While profitability has traditionally been considered the main objective of businesses—often relegating design to a secondary role—Buchanan contends that profit should be seen as a necessary component to sustain the organization and enhance its capacity for innovation in the face of change. Therefore, design can be used to cultivate collaborative interactions that drive NPD, positioning innovation as a key business goal. By broadening the scope of design beyond traditional graphic and industrial applications to include interaction and organizational design, Buchanan (2001) integrates design into the broader operational framework of companies. He suggests that design fosters cohesion across

human activities, acting as a guiding structure that aligns a shared vision and efficiently organizes resources to achieve that vision.

In this context, design becomes closely aligned with the principles of organizational design in the field of management. Simon (1945) defines design as the creation of actions, systems, or physical structures that support a specific objective. Similarly, Senge (1990) highlights that design plays a critical role in understanding both internal and external forces driving change and in shaping learning processes that empower entrepreneurs to adapt. As a result, embedding design within a company's knowledge systems enhances innovation management, supporting the creation of new products in dynamic and competitive markets (Boland & Collopy, 2004).

3. Methodology

This paper focuses on positioning the role of Design in the specific context of local realities of production in Italy for the implementation of platform-based manufacturing. Particularly, this work investigates the case of Janus 5.0, a new model of manufacturing platform intended for optimizing new product development of small metalworking companies in Tuscany region. Through one semistructured interview to the co-founder of Janus 5.0, the paper explores the limits of implementing platform-based manufacturing in unbranded manufacturing companies, the perceived role of Design in these realities and the potential implications for Design to position itself as a competitive capability for organizational design strategies.

The interview verted around three main questions:

1) Which are the challenges for platform providers in implementing a collaborative manufacturing model in unbranded, local realities of production?
2) What is the current role of design in these realities?
3) What could be the potential role of design in local relities of production if Janus 5.0 would be adopted by manufacturers?

Since the platfrom providers of Janus 5.0 already collected quantitative data and conducted several focus groups in local production realities to understand business possibilities for the platform implementation, this research focused on capturing insights to set the first stages of technology adoption from a Design perspective by relying on providers' insights.

3.1 The Platform Janus 5.0

Janus 5.0 is the prototype of a platform for collaborative manufacturing (Barenji et al., 2021) between traditional and geographically dispersed manufacturing machines. The project aims to develop an artificial intelligence platform designed to implement an innovative production model based on the principles of Shared Manufacturing, Collaborative Manufacturing, and Manufacturing-as-a-Service. This model seeks to ensure timely access to factory services and resources through a Peer-to-Peer (P2P) approach, thereby expanding the scope and depth of resource sharing while promoting flexible cooperation.

In traditional manufacturing, machines assigned to specific tasks are typically confined to a single workshop or company. In contrast, Janus 5.0 model envisions machine tools distributed across various globally located workshops, all interconnected through a P2P network. The platform Janus 5.0 will enable the systematic integration of this extensive production capacity by leveraging a sophisticated combination of hardware and software technologies, incorporating the Internet of Things (IoT), Machine-to-Machine (M2M) communication, and Artificial Intelligence (AI). These technologies will function cohesively, effectively transforming a dispersed network of manufacturers into a unified, larger enterprise. The platform will facilitate the sharing and networking of available "machine hours," allowing companies to sell their excess production capacity to other manufacturing firms, thereby embracing the concept of Manufacturing-as-a-Service.
The model of Janus 5.0 is structured around a cost-sharing approach: rather than duplicating financial efforts, it allows for risk mitigation at each stage of large-scale production, minimizing capital expenditures while focusing and specializing investments. Janus 5.0's "asset-light" framework introduces unprecedented levels of flexibility throughout the entire manufacturing process, enabling businesses to leverage advanced expertise and shared production services. This approach accelerates time-to-market while simultaneously reducing costs and risks. Manufacturing firms will have the opportunity to maximize the utilization of their equipment and assets. By sharing resources with other value chain stakeholders, businesses can ensure continuous production operations or at least strive to optimize their production capacity.

In essence, Janus 5.0 will operate as a marketplace for machine hours and residual production capacity, and independent and unorganized entities will be able to participate in manufacturing activities via P2P collaborations by sharing factory resources.

Janus 5.0 can be regarded as a strategic tool to achieve key objectives in the manufacturing sector, including enhanced production efficiency, financial sustainability, reduced delivery times, lower overall costs, and improved environmental sustainability.

4. Results

The interview with the co-founder of Janus 5.0 led to the results shown in Table 1.

Table 1. Insights from the semi-structured interview

Exploration drivers	**Main insights collected**
Main challenges in implementing Janus 5.0 in local metalwork SMEs	Manufacturers scarcely trust the platform model of manufacturing in its collaborative feature. The sharing of manufacturing data with other manufacturers is a critical aspect that limits the implementation of Janus 5.0
The current role of Design in local SMEs	Styling/product specifications, often external capability to the company. E.g. the Brand provide manufaturers with product styles/specifications
The envisioned role of Design in local SMEs with the application of Janus 5.0	Product designer, internal resource of the company. Develop the design of custom products when requests arises by external manufacturers.

The importance of trust relationships has emerged as a critical determinant for manufacturers when considering participation in the Janus 5.0 platform. In platform-based ecosystems, trust constitutes the foundational element that underpins successful collaboration, particularly when multiple stakeholders are engaged in the exchange of sensitive data and resources. For manufacturers, the decision to join such a platform transcends the evaluation of its technological capabilities and includes a consideration of the system's reliability, transparency, and the integrity of other participants. Trust facilitates the secure exchange of information, coordination of efforts, and alignment of objectives among diverse actors within the platform. In the absence of trust, manufacturers may be reluctant to engage in collaborative activities, thereby impeding the platform's potential for growth and operational success. Consequently, platform providers must prioritize the cultivation of trust-building strategies that foster positive relational dynamics, ensuring that participants perceive their involvement as mutually beneficial and conducive to the long-term sustainability of the platform ecosystem.

As far as the role of Design is concerned, it is currently delegated to external entities, such as brands, which provide manufacturers with predefined product styles and specifications. Unbranded SMEs in the metalworking sector generally do not require substantial internal design capabilities focused on functional or technical problem-solving, as their product development processes are predominantly guided by external design specifications, such as aesthetic style. These firms typically depend on external entities, such as brand owners or design consultants, to provide detailed directives on the appearance and design elements of their products, rather than fostering internal design expertise to address these aspects. As a result, the role of design within these SMEs is often confined to the implementation and manufacturing of products in alignment with predefined guidelines, with little emphasis placed on the innovation or technical refinement of the design itself.

Finally, the role of design in the context of MaaS is primarily envisioned as the development of Computer-Aided Design (CAD) models for customized products, which can then be ordered directly from a digital marketplace. In this framework, design functions as a crucial enabler by converting customer specifications into precise, manufacturable digital blueprints, facilitating the integration of personalized products into the platform. These CAD models allow for the streamlined ordering of customized products, thus enhancing the flexibility and responsiveness of the manufacturing process. However, it is important to highlight that this role of design is predominantly concerned with the technical and product-specific dimensions, with less emphasis placed on strategic design elements, such as long-term innovation, brand identity, or market positioning. In this regard, design in the MaaS model primarily serves to optimize product customization and manufacturing efficiency, while strategic design considerations—related to competitive advantage, differentiation, and organizational direction—are not typically addressed within this operational scope. Thus, design contributes to the immediate

functional needs of MaaS but does not engage with the broader strategic and organizational dimensions that could shape the platform's evolution and long-term success.

5. Discussion

The integration of platform-based technologies into networks of local manufacturers requires deliberate and continuous efforts by platform providers to establish and maintain trust among participants. The adoption of manufacturing platforms necessitates that firms share substantial amounts of manufacturing data, making trust in both the technological infrastructure and platform users essential. Consequently, manufacturing companies are more likely to engage with the Janus 5.0 platform if they have confidence not only in the system itself but also in the stakeholders involved. From this perspective, the successful implementation of the platform must prioritize the development of effective engagement strategies. Benkler (2008) asserts that social exchange operates within a less clearly defined framework that can facilitate profitability. Given that the network effects crucial to the success of Janus 5.0 generate mutual economic benefits for all stakeholders, platform providers should focus on designing strategies that strengthen relationships among system participants.

This bottom-up approach to NPD has emerged as a relatively recent perspective in research on entrepreneurial ecosystems (Spigel, 2018). Studies adopting this approach frequently draw upon complex adaptive systems theory, which examines microscopic interactions at the individual level and assesses their broader macro-level implications (Holland, 2006; Levin, 2002). From this theoretical standpoint, entrepreneurial ecosystems drive growth by fostering dynamic and interdependent relationships among participants. Roundy (2020) characterizes interdependence as the extent to which participants' tasks and objectives are mutually connected. In this context, the relational dimension of entrepreneurial ecosystems—particularly the interactions among entrepreneurial actors—assumes a central role in research that adopts a community-based perspective on the entrepreneurial process (Fredin & Lidén, 2020). Understanding the collaborative dynamics within these ecosystems is essential, as the absence of such relationships would compromise the functionality of the ecosystem as a whole.

By focusing on individual-level interactions, the bottom-up perspective on entrepreneurship offers significant insights into the evolution and development of the MaaS model. This approach emphasizes relationship-building, positioning engagement as a critical lens through which the role of Design is examined. This perspective aligns with Björgvinsson et al.'s (2010) conceptualization of Design in multi-actor environments, in which they describe design as an ongoing process of co-creation that interweaves people, objects, and processes. Furthermore, when Design considers the interconnection between technical, social, and organizational aspects, it actively contributes to infrastructuring activities (Karasti, 2014). Expanding on this concept, Bødker et al. (2017) define Design for infrastructuring as a set of targeted actions aimed at fostering the participation of diverse stakeholders in the development of new initiatives. Therefore, the success of collaborative manufacturing infrastructure in local production contexts largely depends on the willingness of local manufacturers to collaborate toward a shared goal—gaining a competitive advantage through a platform-based manufacturing model. Design plays a crucial role as an organizational driver by enhancing entrepreneurial motivation and promoting large-scale engagement through design-driven initiatives (Dastoli, 2022; Dastoli et al., 2021). While participatory design literature (Simonsen & Robertson, 2013) traditionally associates the role of Design in complex socio-technical systems with facilitation activities, Bødker et al. (2017) argue that its function should not be confined to facilitation alone but should also extend to its preparatory aspects, referred to as the process of "tying different knots." These preparatory activities are crucial for enabling multiple actors to effectively participate in new product development. Within this framework, staging activities leverage cognitive design capabilities that support relational interactions throughout the entire product development process.

Conclusions

This study examines the role of design in the adoption of industry platforms, particularly in the context of local, unbranded production environments. Through an analysis of Janus 5.0—a collaborative manufacturing platform model tailored for metalworking companies in Tuscany, Italy—the research provides valuable insights into how design influences this transition.

The integration of Manufacturing as a Service (MaaS) within small enterprises in industrial districts brings about a fundamental transformation in the competitive landscape. Instead of adhering to a traditional model based on direct competition, firms shift toward a goal-oriented approach. In this redefined framework, businesses

prioritize shared objectives such as increasing production efficiency, optimizing resource allocation, and fostering collaborative innovation rather than focusing solely on surpassing local competitors. This evolution allows companies to capitalize on digital platforms, cloud-based manufacturing resources, and integrated supply chains, ultimately generating mutual advantages. As a result, competition becomes less about individual market dominance and more about collectively developing capabilities that enhance the overall competitiveness of the industrial district. However, for this transition to be effectively implemented among manufacturers, platform providers must focus on relationship-building strategies centered on trust. Within this context, design emerges as a fundamental organizational capability for platform-based manufacturing. Its significance extends beyond its conventional association with aesthetics or product development, instead functioning as a strategic mechanism for managing the intersection of technical, social, and organizational structures. Andreasen et al. (2015) suggest that design plays a crucial role in structuring team collaboration and project coordination, thereby facilitating cooperative processes. This perspective is closely linked to the concept of "infrastructuring," as described by Karasti (2014), which refers to the way design establishes new opportunities for stakeholder engagement at a systemic level. Similarly, Giaccardi and Fischer (2008) highlight the role of design in shaping these spaces, enabling dynamic stakeholder interactions.

By leveraging design in this way, platform providers can develop an infrastructure that promotes the alignment of stakeholder interests around common goals and values, while simultaneously maintaining the adaptability needed to respond to shifting market conditions. Additionally, design supports the integration of both technical and social aspects of collaboration, ensuring the smooth interaction necessary for the platform's long-term success. As a result, design functions not only as a strategic facilitator but also as a crucial linking element, helping platform-based manufacturing systems to evolve and sustain enduring partnerships.

Acknowledgements

The authors would like to express their sincere gratitude to BRT Consulting s.r.l. for generously sharing valuable information regarding the Janus 5.0 model and for their support and availability in participating in the development of this research.

References

Andreasen, M. M., Hansen, C. T., & Cash, P. (2015). Conceptual design: Interpretations, mindset and models. *Conceptual Design: Interpretations, Mindset and Models*, 1–394. https://doi.org/10.1007/978-3-319-19839-2

Barenji, A. V., Guo, H., Wang, Y., Li, Z., & Rong, Y. (2021). Toward blockchain and fog computing collaborative design and manufacturing platform: Support customer view. *Robotics and Computer-Integrated Manufacturing, 67*, 102043. https://doi.org/10.1016/j.rcim.2020.102043

Becattini, G. (2002). From Marshall's to the Italian "Industrial districts". A brief critical reconstruction. In *Complexity and industrial clusters* (pp. 83–106). Physica-Verlag HD.

Benkler, Y. (2008). *The Wealth of Networks*. Yale University Press.

Bertola, P., & Teixeira, J. C. (2003). Design as a knowledge agent: How design as a knowledge process is embedded into organizations to foster innovation. *Design Studies, 24*(2), 181-194. https://doi.org/10.1016/S0142-694X(02)00033-6

Björgvinsson, Erling, Ehn, P., & Hillgren, P. A. (2010). Participatory design and "democratizing innovation." *ACM International Conference Proceeding Series*, *Ehn 1988*, 41–50. https://doi.org/10.1145/1900441.1900448

Boland, R., & Collopy, F. (Eds.). (2004). *Managing as Designing*. Stanford business books.

Bødker, S., Dindler, C., & Iversen, O. S. (2017). Tying Knots: Participatory Infrastructuring at Work. *Computer Supported Cooperative Work: CSCW: An International Journal*, *26*(1–2), 245–273. https://doi.org/10.1007/s10606-017-9268-y

Buchanan, R. (2001). Design Research and the New Learning. *Design Issues*, *17*(4), 3–23. https://doi.org/10.1162/07479360152681056

Buchanan, R. (2004). Management and Design: Interaction Pathways in Organizational Life. In Richard Boland & F. Collopy (Eds.), *Managing as Designing* (pp. 54–63). Stanford University Press.

Buchanan, R. (2015). Worlds in the Making: Design, Management, and the Reform of Organizational Culture. *She Ji*, *1*(1), 5–21. https://doi.org/10.1016/j.sheji.2015.09.003

Camarinha-Matos, L. M., Afsarmanesh, H., Galeano, N., & Molina, A. (2009). Collaborative networked organizations - Concepts and practice in manufacturing enterprises. *Computers and Industrial Engineering*, *57*(1), 46–60. https://doi.org/10.1016/j.cie.2008.11.024

Cautela, C., Simoni, M., & Moran, P. (2022). Microfoundations of dynamic design capabilities: An empirical analysis of "excellent" Italian design firms. *Journal of Product Innovation Management, 39*(1), 3-23. https://doi.org/10.1111/jpim.12643

Dastoli, C. (2022). *Design capabilities and entrepreneurial ecosystems: Investigating design under an adaptive logic of competition for developing new products in manufacturing* (Doctoral dissertation, Politecnico di Milano). https://doi.org/10.13140/RG.2.2.25214.84808

Dastoli, C., Del Curto, B., Cautela, C., & Teixeira, C. (2021). Design capabilities and entrepreneurial ecosystems: Envisioning a new role that design can play in manufacturing. In *Proceedings of the 28th Innovation and Product Development Management Conference (IPDMC)* (pp. 1-23).

Fredin, S., & Lidén, A. (2020). Entrepreneurial ecosystems: towards a systemic approach to entrepreneurship? *Geografisk Tidsskrift - Danish Journal of Geography* , *120*(2), 87–97. https://doi.org/10.1080/00167223.2020.1769491

Fry, A., Goretti, G., Ladhib, S., Cianfanelli, E., & Overby, C. (2017). "Advanced craft" integrated with the saper fare; the role of intangible value, and the centrality of the artisan in highquality 21st century artisanship. *Cuadernos del Centro de Estudios en Diseño y Comunicación. Ensayos*, (64), 255-276.

Gawer, A., & Cusumano, M. A. (2014). Industry platforms and ecosystem innovation. *Journal of Product Innovation Management, 31*(3), 417-433. https://doi.org/10.1111/jpim.12105

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy*, *33*(6–7), 897–920. https://doi.org/10.1016/j.respol.2004.01.015

Giaccardi, E., & Fischer, G. (2008). Creativity and evolution: A metadesign perspective. *Digital Creativity, 19*(1), 19–32. https://doi.org/10.1080/14626260701847456

Helo, P., Hao, Y., Toshev, R., & Boldosova, V. (2021). Cloud manufacturing ecosystem analysis and design. *Robotics and Computer-Integrated Manufacturing, 67*, 102050. https://doi.org/10.1016/j.rcim.2020.102050

Holland, J. H. (2006). Studying complex adaptive systems. *Journal of Systems Science and Complexity*, *19*(1), 1–8. https://doi.org/10.1007/s11424-006-0001-z

Junginger, S. (2008). Product development as a vehicle for organizational change. *Design Issues*, *24*(1), 26–35. https://doi.org/10.1162/desi.2008.24.1.26

Karasti, H. (2014). Infrastructuring in participatory design. *ACM International Conference Proceeding Series*, *1*, 141–150. https://doi.org/10.1145/2661435.2661450

Kelly, K. (2010). *What Technology Wants*. Penguin Books.

Kusiak, A. (2019). Service manufacturing: Basic concepts and technologies. *Journal of Manufacturing Systems, 52*, 198–204. https://doi.org/10.1016/j.jmsy.2019.07.005

Levin, S. A. (2002). Complex adaptive systems: Exploring the known, the unknown and the unknowable. *Bulletin of the American Mathematical Society*, *40*(1), 3–19.

Liu, Y., Wang, L., Wang, X. V., Xu, X., & Jiang, P. (2019). Cloud manufacturing: key issues and future perspectives. *International Journal of Computer Integrated Manufacturing*, *32*(9), 858-874.

Neff, G., Jordan, T., McVeigh-Schultz, J., & Gillespie, T. (2012). Affordances, Technical Agency, and the Politics of Technologies of Cultural Production. *Journal of Broadcasting and Electronic Media*, *56*(2), 299–313. https://doi.org/10.1080/08838151.2012.678520

OECD. (1996). *The Knowledge Based Economy*.

Porter, M. E., & Heppelmann, J. E. (2014). How Smart, Connected Products Are Transforming Competition. *Harvard Business Review*.

Porter, M. E., & Kramer, M. R. (2011). Creating shared value. *Harvard Business Review*, *89*(1–2). https://doi.org/10.32591/coas.ojss.0201.04037b

Rindova, V., & Courtney, H. (2020). To shape or adapt: Knowledge problems, epistemologies, and strategic postures under Knightian uncertainty. *Academy of Management Review, 45*(4), 787–807. https://doi.org/10.5465/amr.2018.0193

Roos, G. (2014). The constantly changing manufacturing context. *Advanced Manufacturing - Beyond the Production Line*, *August*, 31–56.

Roundy, P. T. (2020). The wisdom of ecosystems: A transactive memory theory of knowledge management in entrepreneurial ecosystems. *Knowledge and Process Management*, *27*(3), 234–247.

Scaringella, L., & Radziwon, A. (2018). Innovation, entrepreneurial, knowledge, and business ecosystems: Old wine in new bottles? *Technological Forecasting and Social Change*, *136*(December 2015), 59–87. https://doi.org/10.1016/j.techfore.2017.09.023

Schilling, M. A. (2010). *Strategic Management of Technological Innovation.* Tata McGraw-Hill Education.

Schumpeter, J. A. (1942). *Capitalism, socialism and democracy*. Harper.

Schrage, M. (2014). *The innovator's hypothesis: How cheap experiments are worth more than good ideas*. MIT Press.

Senge, P. M. (1990). *The Firth Discipline: The Art & Practice of the Learning Organization*. Doubleday.

Simon, H. A. (1945). *Administrative Behavior: A Study of Decision-Making Processes in Administrative Organizations*. Free Press.

Simonsen, J., & Robertson, T. (2013). *Routledge International Handbook of Participatory Design*. Routledge. http://www.routledge.com/books/details/9780415694407/

Spigel, B. (2018). Envisioning a New Research Agenda for Entrepreneurial Ecosystems: Top-down and Bottom-up Approaches. In J. A. Katz & A. C. Corbett (Eds.), *Reflections and Extensions on Key Papers of the First Twenty-Five Years of Advances (Advances in Entrepreneurship, Firm Emergence and Growth, Vol. 20)* (pp. 127–147). Emerald Publishing Limited.

Terkaj, W., Tolio, T., & Urgo, M. (2015). A virtual factory approach for in-situ simulation to support production and maintenance planning. *CIRP Annals, 64*(1), 451–454. https://doi.org/10.1016/j.cirp.2015.04.061

Tolio, T. A. M., Monostori, L., Váncza, J., & Sauer, O. (2023). Platform-based manufacturing. *CIRP Annals, 72*(2), 697-723. https://doi.org/10.1016/j.cirp.2023.05.006

Whitney, P. (2015). Design and the Economy of Choice. *She Ji: The Journal of Design, Economics, and Innovation*, *1*(1), 58–80. https://doi.org/10.1016/j.sheji.2015.09.001