Rethink Large Scale Agile Organization with Robotics Subsumption Architecture

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1. Introduction

Scaling is not simply about creating more of the same.

Many organizations scale through replication. Manufacturing companies build additional factories using established production systems, while franchise businesses expand by replicating proven operating models across new locations. Each unit largely functions as an independent whole. Scaling is achieved by repeating a successful model.

Large-scale Agile organizations face a fundamentally different challenge. A software product cannot be developed by simply replicating Agile teams. Instead, autonomous teams each contribute part of a larger product that must be continuously integrated with the work of other teams [1,2]. As the number of teams grows, so do the dependencies between them. The challenge is therefore not simply adding more teams, but designing an organization in which autonomous teams collectively contribute to an integrated whole while preserving the autonomy that makes Agile effective.

This paper argues that large-scale Agile organizations face **two fundamental challenges**. **First**, software development scales through integration rather than replication, making it fundamentally different from many traditional forms of organizational scaling. **Second**, although Agile transformed how individual teams are organized, organizations continue to rely largely on traditional hierarchical structures and coordination mechanisms to integrate their work. As organizations grow, coordination overhead increases, decision-making becomes more centralized, and team autonomy gradually diminishes [3].

Most Agile scaling frameworks respond by adding coordination mechanisms, planning events, organizational structures, and synchronization activities. While these improve alignment, they continue to treat scaling primarily as a coordination problem. We argue that the more fundamental challenge is one of **organizational systems design**: how to design an organization in which autonomous organizational units contribute to larger integrated systems while preserving their autonomy.

Similar principles can be observed in nature, where autonomous subsystems collectively produce coherent behavior without centralized intelligence or comprehensive global planning. A similar engineering model can be found in Rodney Brooks' revolutionary Robotics

Subsumption Architecture, in which decentralized behavioral layers interact directly with the environment, enabling real-time adaptive behavior without centralized control [4].

Inspired by the late Mike Beedle's vision of applying Subsumption Architecture to organizational design [5], this paper proposes an organizational systems design approach for large-scale Agile organizations in which autonomous organizational units contribute to progressively larger integrated systems while preserving their autonomy.

2. Background: Robotics Subsumption Architecture

In the mid-1980s, Rodney Brooks challenged the prevailing paradigm in artificial intelligence and robotics. At the time, intelligent systems were typically designed around centralized control, comprehensive world models, and global planning. A robot was expected to construct an internal representation of its environment, determine an appropriate course of action, and then execute that plan. While effective in controlled environments, these systems were often computationally expensive, slow to respond, and difficult to adapt to dynamic, unpredictable conditions.

Brooks proposed an alternative known as the **Subsumption Architecture**, a layered control architecture that eliminated the need for centralized intelligence and comprehensive world models. Instead of relying on a single controller, the architecture consists of multiple autonomous behavioral layers that interact directly with the environment. Each layer continuously senses its surroundings, makes local decisions, and generates behavior independently [4].

The layers are organized hierarchically, with higher layers capable of influencing lower layers through suppression or inhibition when appropriate. Rather than replacing lower-level behaviors, higher layers augment them by introducing additional capabilities while preserving the autonomy and responsiveness of the underlying layers. As new layers are added, increasingly sophisticated system behavior emerges without redesigning the existing architecture [4].

A fundamental principle of the Subsumption Architecture is that coherent system behavior emerges through the interaction of autonomous components rather than through centralized control. Intelligence is distributed across behavioral layers, each responding to local environmental conditions in real time. This decentralized approach enables systems to remain adaptive, robust, and responsive in complex environments.

Although originally developed for autonomous robots, the architectural principles underlying the Subsumption Architecture extend beyond robotics. The combination of autonomous units, layered organization, local decision-making, decentralized interaction, and emergent system behavior provides a compelling engineering model for designing adaptive systems. These principles form the foundation for the organizational systems design presented in this paper.

3. The Organizational Design Challenge

Organizations developing large, integrated software products face a fundamental organizational challenge. As products grow in size and complexity, so do the interactions among the autonomous teams responsible for building them. Maintaining product coherence therefore requires mechanisms for integrating the work of many organizational units.

Traditional organizations address this challenge primarily through hierarchical coordination. Additional management layers, governance bodies, planning events, architecture reviews, portfolio management, and dependency coordination are introduced to align work across teams. While these mechanisms improve organizational alignment, they also increase coordination overhead and gradually constrain the autonomy that Agile teams were designed to achieve [3].

This is not a failure of Agile. Rather, it reflects the absence of an organizational systems design capable of integrating autonomous organizational units without relying primarily on centralized coordination. As organizations continue to grow, the need for coordination grows with them.

The question, therefore, is not simply how to coordinate more teams. The more fundamental question is how to design an organization in which autonomous organizational units can interact locally, adapt continuously, and collectively produce coherent organizational behavior. The next section presents an organizational systems design inspired by Robotics Subsumption Architecture that addresses this challenge.

4. Organizational Systems Design Through Subsumption

Robotics Subsumption Architecture offers more than an alternative control mechanism for autonomous robots; it provides a fundamentally different approach to designing adaptive systems. Rather than relying on centralized intelligence, coherent system behavior emerges through the interaction of autonomous entities responding to their local contexts. We apply these same architectural principles to the design of large-scale Agile organizations.

The proposed organizational systems design is composed of autonomous organizational sub-units that operate within their own contexts while contributing to larger integrated organizational systems. Organizational coherence is achieved not through centralized decision-making, but through structured interactions among autonomous organizational sub-units.

Communication occurs primarily through organizational signals rather than centralized command. Organizations respond rapidly to changing customer needs, market conditions, technology, operations, regulations, and other environmental conditions through organizational signals. Organizational sub-units interpret these signals within their own context, make local decisions, and respond independently whenever possible.

Organizations, however, require more than autonomous execution. They must also continuously recognize emerging patterns, connect related concerns across organizational boundaries, and ensure that important organizational actions are initiated and carried through. This adaptive capability is provided by **Surfers**.

4.1 Design Principles

Organizing Context

The design of an organization begins by identifying its **organizing context**—the primary context around which the organization creates and delivers value. The organizing context guides how related capabilities are composed into organizational sub-units and integrated into progressively larger organizational structures. Because organizations differ in how they create value, the organizing context is not universal; it reflects the business model and strategic intent of the enterprise.

Subsumption

Once the organizing context has been established, related capabilities are progressively composed into organizational sub-units. Each sub-unit represents a coherent area of responsibility with the autonomy to make decisions within its own context. These organizational sub-units are then integrated into progressively larger organizational layers while preserving their local autonomy.

Unlike traditional hierarchical decomposition, subsumption focuses on composing related capabilities into larger organizational wholes rather than partitioning responsibilities into smaller units. Consequently, the organizational layers are derived from the organizing context rather than prescribed as fixed organizational levels. Different organizations may therefore produce different organizational architectures while following the same design principles.

4.2 Adaptive Organizational Operation

Organizational signals provide the primary communication mechanism for decentralized coordination. In practice, these signals are made visible through organizational information radiators, such as organizational canvases, dashboards, or Andon-style visual management systems. These information radiators provide transparency into the activities and current state of organizational sub-units, creating shared situational awareness across the organization. Organizational sub-units continuously interpret and respond to these signals within their own context, enabling rapid adaptation to changing customer needs, market conditions, technology, operations, regulations, and other environmental conditions.

Surfers provide the complementary adaptive capability. As stewards accountable for specific organizational responsibilities, they continuously monitor these responsibilities, recognize emerging patterns, facilitate collaboration across organizational sub-units, and ensure that

appropriate organizational actions are initiated and carried through, while the work itself is performed by the organizational sub-units.

Together, organizational signals, organizational sub-units, and Surfers enable the organization as a whole to continuously adapt while preserving local autonomy. Rather than relying primarily on centralized command and coordination, organizational coherence emerges through structured interactions among these elements.

The following section demonstrates how these design principles and adaptive mechanisms can be applied in practice through the eAuction example.

5. Applying the Organizational Systems Design: The eAuction Example

To illustrate how the proposed organizational systems design approach can be applied, consider the fictional company **eAuction**. This example is not a real case study, but a simplified scenario used to demonstrate how an Agile organization can scale while preserving autonomy and organizational coherence.

eAuction is a digital marketplace that enables customers to auction products across multiple industries. Initially focused on airline ticket auctions, the company later expands into entertainment and fine arts. As the business grows, it requires an organizational system that can scale without sacrificing the autonomy, adaptability, and responsiveness that fueled its early success.

5.1 Startup Phase

eAuction initially operates like a startup, with a single cross-functional team exploring whether there is a viable need for its online auction service. The company chooses the **airline industry** as its initial market. The team includes marketing and sales, software development, and business capabilities working together to understand the needs of airline customers and passengers and discover viable value propositions.

As the business grows and its understanding of the airline market becomes clearer, the startup team evolves into specialized but autonomous teams. The **Airline Marketing & Sales Team** engages with the market and customers, gathering feedback and supporting positioning, messaging, campaigns, and sales. The **Airline Auction Team** focuses on a specific value proposition and its associated business model. The **Airline Customer Segment Team** focuses on the portfolio of value propositions serving airline customers and passengers. These teams work together within the Airline Customer Segment, guided by the Leadership Team.

Figure 1 illustrates this evolution and the responsibilities of each team. The descriptions beneath the teams highlight their respective contributions and show how initially integrated startup capabilities become autonomous organizational sub-units as eAuction grows.

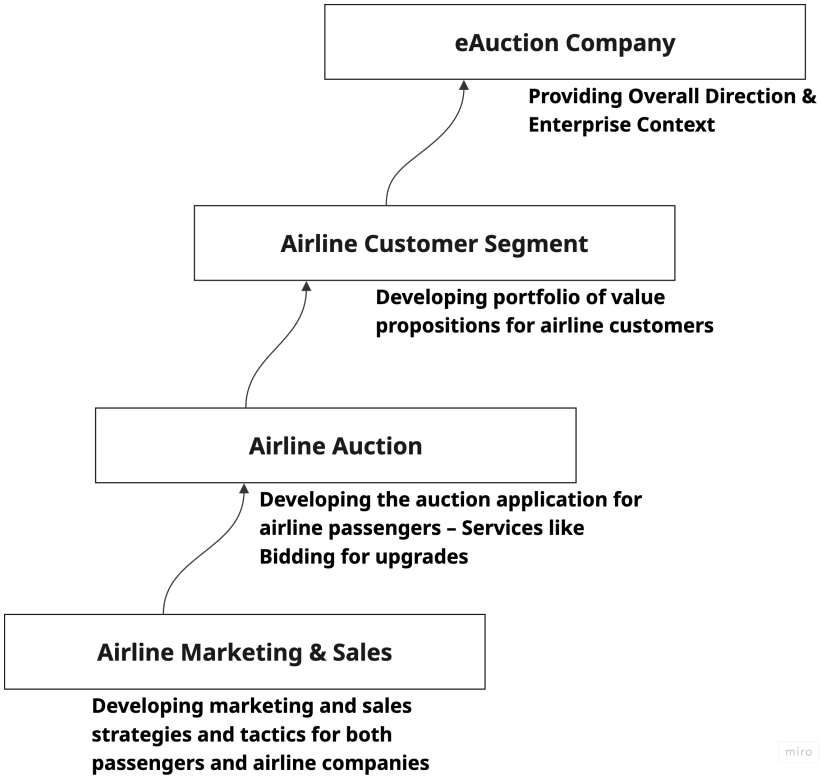

Figure 1. eAuction organizational architecture during the startup phase.

5.2 Defining the Organizing Context

Through its startup phase, eAuction learns that a **specific customer segment and the value propositions that serve it** provide a meaningful basis for organizing the business. It therefore adopts the **customer segment** as the organizing context for further growth. A customer segment may be served by one or multiple value propositions.

Organizing around customer segments allows related value propositions and capabilities to be composed into organizational sub-units that directly support the needs of a particular group of customers rather than traditional functional departments. Individual **Products & Services teams** focus on specific value propositions, while a **Customer Segment team** focuses on the portfolio of value propositions serving that customer segment.

As eAuction grows, Customer Segments are progressively composed into **Business Units**, and Business Units into the **Company**. Each successive layer operates within a broader context while subsuming the autonomous organizational sub-units within it. These layers are specific to eAuction; other organizations may derive different layers based on their organizing context.

5.3 Scaling Through Additional Customer Segments

With the organizing context established, eAuction expands beyond Airline into **Entertainment** and **Fine Arts**. The same organizing approach is applied to each new customer segment: Products & Services teams focus on specific value propositions, while each Customer Segment team focuses on the portfolio of value propositions serving its particular customers.

As Airline and Entertainment both involve ticket-based auctions, their Customer Segments are composed within the **Ticketing Business Unit**. At this layer, the Business Unit Team focuses on the portfolio of Customer Segments and the broader concerns shared across them. A **Shared Platform Team** provides common auction capabilities across Airline and Entertainment, reducing duplication while allowing each Customer Segment to remain autonomous.

Fine Arts, however, introduces a substantially different business model. Auctioning artwork rather than tickets requires different applications, workflows, customer interactions, and capabilities. The Fine Arts Customer Segment is therefore composed within a separate **Products Business Unit**, reflecting the different context in which its customer value is created and delivered. At the Company layer, the **eAuction Company Team** focuses on the portfolio of Business Units and the overall enterprise context. In this way, the organizational architecture progressively expands from specific value propositions, to portfolios of value propositions within Customer Segments, to portfolios of Customer Segments within Business Units, and finally to the portfolio of Business Units within the Company.

Figure 2 illustrates the resulting architecture. The dashed boundaries represent organizational sub-units, or instances, composed within progressively larger subsumption layers.

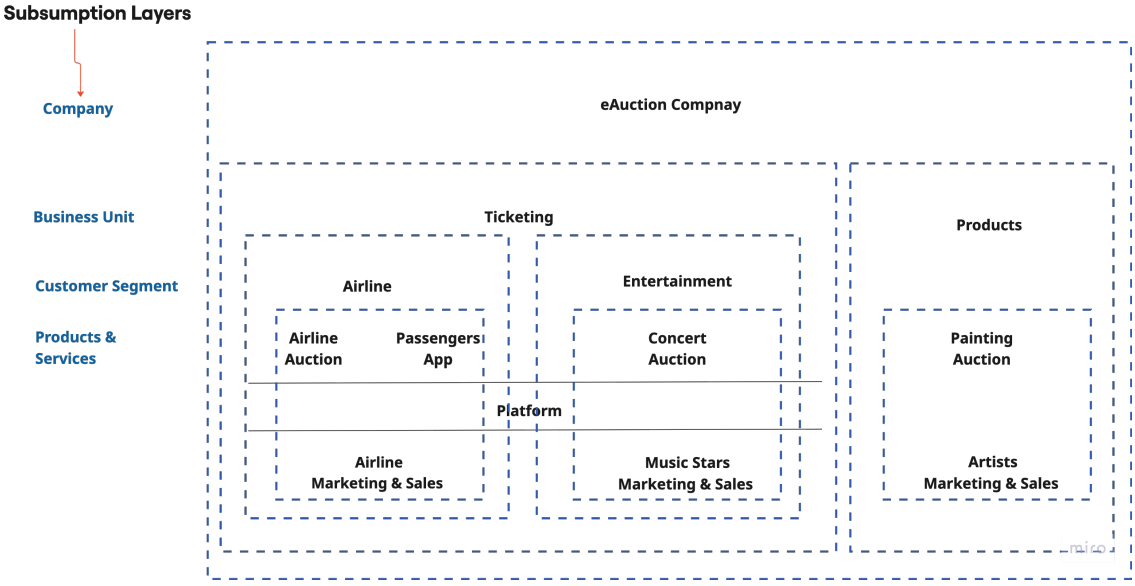

Figure 2. Expanded eAuction organizational architecture for Airline, Entertainment, and Fine Arts.

5.4 Organization-wide Supporting Teams

As eAuction continues to grow, certain capabilities are needed broadly across Customer Segments and Business Units. Organization-wide supporting teams provide common services across the enterprise, while specialized capabilities may also exist within individual Business Units where needed.

Examples of organization-wide supporting teams include **Governance, Talent Harmony, Transformation, Supporting, and Compliance**. These teams provide common services across the organization while preserving the autonomy of the organizational sub-units they support.

5.5 Adaptive Organizational Operation

Each team maintains a canvas that visualizes its objectives, current activities, dependencies, and other key information. These canvases serve as information radiators, providing transparency into what teams are doing and creating shared situational awareness across the organization.

Organizational signals communicate information that may require attention or response. Teams can set signals for conditions relevant to their work and subscribe to signals from other teams to be notified when those conditions arise. Surfers monitor signals within their areas of responsibility and step in when broader coordination or action across organizational sub-units is needed.

For example, a major storm may cause widespread flight cancellations, triggering signals as cancellation levels spike. The airline's priority may then shift from maximizing revenue to passenger rebooking and recovery. Surfers can step in to establish the necessary constraints and rapidly carry the airline's intent across organizational layers. Actions may include disabling bidding, prioritizing seating, and modifying eligibility rules. The affected teams respond within their own contexts while integrating their actions toward the shared goal of passenger recovery.

Through transparency, organizational signals, and Surfer stewardship, autonomous teams can coordinate their responses and enable the organization as a whole to adapt rapidly to changing conditions.

6. Conclusion

The proposed organizational systems design reframes Agile scaling as an organizational design problem rather than a team coordination problem. Inspired by Brooks' Robotics Subsumption Architecture, the approach provides design principles for composing autonomous

organizational sub-units into adaptive organizational systems while preserving local autonomy and organizational coherence.

Rather than prescribing a fixed organizational structure, the approach derives organizational architectures from an organization's **organizing context**. In the eAuction example, **customer segments serve as the organizing context, with each segment encompassing one or more value propositions**. As the organization scales, these sub-units are progressively composed into broader contexts while retaining their autonomy. Other organizations may derive different architectures based on their organizing context.

Adaptive operation is enabled through transparency, organizational signals, and Surfer stewardship. Information radiators provide visibility into the activities of teams, while teams set and subscribe to signals that communicate changing conditions requiring attention or response. Surfers monitor these signals and intervene when broader action across organizational boundaries is needed. Together, these mechanisms allow autonomous organizational sub-units to integrate their responses and enable the organization as a whole to adapt rapidly without relying primarily on centralized coordination.

The eAuction example is illustrative rather than empirical. Future work includes applying the approach to organizations, evaluating its effectiveness, and exploring alternative organizing contexts.

The future of Agile scaling lies not in coordinating more teams, but in designing adaptive organizational systems that preserve autonomy while enabling organizational coherence.

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