Component Constellations:
Future Perspectives on Design Systems

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Abstract

During a time of rapid technological and economic change, shifting user preferences and heightened expectations, design systems stand as foundational tools for organizations committed to swiftly developing unified and seamless digital products and services at scale. These systems, which encapsulate a set of design standards, modular components, and design patterns, form a cohesive framework for delivering consistent user-centric applications, while promoting collaboration among product teams.

This research project employs strategic foresight methods to uncover promising transformations within design systems over the next seven years. The project will start by analyzing design system elements, processes, and stakeholders to understand their interdependencies and pinpoint possible directions for future development. It will then investigate the implications of recent emerging trends that could shape design systems of the future, exploring the impact of advances in Artificial Intelligence (AI) and Extended Reality (XR) on the creation of digital products powered by design systems. The research concludes by presenting strategic recommendations for design system professionals to optimize the effectiveness of future design systems, ensuring their sustained innovation and relevance.

Acknowledgments

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To my father, who passed away in January 2021.

His tireless efforts, insightful wisdom, and invaluable advice have been and remain my greatest inspiration.

You are greatly missed, Baba. I hope I made you proud.

About the Author

Ali Salem is a Digital Product Designer based in Toronto, Canada with several years of experience in multidisciplinary design and design systems at scale. In his current role as the Design Systems Lead at Auth0 by Okta, Ali collaborates with cross-functional teams to uphold design standards and create efficient workflows that enable high-velocity user interface creation.

Previously, Ali served as the Visual Design Lead for the RIG Design System at Royal Bank of Canada (RBC) where he supported 700-plus designers and software developers in delivering a unified digital banking experience for RBC customers.

Before embarking on his design systems journey, Ali worked at digital design and innovation agencies in Toronto, Dubai, and Cairo. He was fortunate to collaborate with renowned brands such as Emirates, MasterCard, Jumeirah, Emaar, and several others.

Ali is driven by a profound sense of responsibility to enable and empower others through design and technology. As a systems thinker, he constantly seeks opportunities in the design systems space to create consistent, efficient, and robust experiences that truly stand out.

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Introduction

Technology is undoubtedly fascinating. Over the past few decades, it has progressed so rapidly that keeping up with the various ways it has transformed our lives is challenging. Take, for example, the small device we carry in our pockets — the smartphone. This gadget is a powerhouse of endless capabilities, enabling us to shop comfortably from our homes, trade stocks with just a few taps, watch live concerts, play video games, and even diagnose and care for indoor and garden plants (Mobilian, 2022). It is truly remarkable that realizing many of these possibilities was once considered science fiction, highlighting the incredible pace at which technology continues to evolve and the creative ways we employ it. Consider Generative Artificial Intelligence (GenAI), for instance, and how it is upgrading our use of the internet, making it smarter and more personal (Curtis et al., 2023). This innovative area of AI is not just creating content that rivals human creativity in art and media, it is also revolutionizing problem-solving across industries such as health care and drug discovery. For example, Absci, a drug creation company, has recently succeeded in using GenAI and machine learning to create new antibodies, which are crucial components of our immune system (Cumbers, 2023). This is just one of the many examples of how AI is transforming various domains and industries. Another domain that is undergoing rapid change is the field of Augmented Reality (AR) and Virtual Reality (VR), which redefine our engagement with the digital world, moving us beyond flat screens. With its soon-to-be-released product, Vision Pro, Apple is betting on AR to enhance our everyday environments and perceptions of the world (Apple, 2023). Meanwhile, Meta is breaking new ground in VR with its Metaverse, creating immersive social, entertaining, and educational experiences (Meta, 2021).

As an avid technology admirer, I am excited about the advancements of these emerging technologies because they represent a revolution in how we interact with the world beyond what we have been accustomed to. They have the potential to solve more complex problems, connect us in new ways, and provide immersive experiences that enrich our daily lives in unimaginable ways.

Technology and Interfaces

At the heart of many technological advancements lies an extensive range of digital products and services, from software and media to gaming and digital collectibles. These applications often count on user interfaces (UI) to facilitate the connection between technology and people, allowing them to leverage its full potential without getting lost in its complexity. UIs can vary widely depending on the type of technology, encompassing everything from touchscreens on smartphones and tablets to voice-activated home assistants and even Extended Reality (XR) environments. The most widely recognized type of UI is the graphical user interface (GUI), used in a variety of electronic devices like computers, smartphones, and automated teller machines

(ATM). In a GUI, users interact with these devices through menus, icons, and other graphical and visual elements. Since its introduction in 1962 with the Sketchpad (Perry & Voelcker, 1989), the GUI has ensured that computers and digital technologies are more accessible to average, less tech-savvy users.

An effective interface is designed to help users complete tasks and fulfill their goals, optimizing their engagement with the technology it operates on. While interfaces bridge human intent and digital capability, crafting these gateways is often complex. In my 15 years as a digital product and UI designer, I have seen how much thought and effort go into making these interfaces simple for users, even though the process is anything but simple.

The Complex Process of Designing and Building Interfaces

The creation of UIs is a historically sophisticated process that involves cross-disciplinary efforts. At its core, the UI design process is about understanding and designing for end users, considering their needs, expectations, and the contexts in which they interact with the product. Brad A. Myers (1993), Professor in the School of Computer Science at Carnegie Mellon University, highlighted that there is a difficulty in designing interfaces arising from the complexity of user tasks, the need to balance various design aspects, and the necessity of an iterative design process. Myers further elaborates that designers must acquire a deep understanding of user tasks while carefully balancing design standards, graphic design, technical writing, internationalization, and even addressing social and legal issues that may arise when adopting a specific design convention.

As we transition to apply the UI design process in large-scale organizations, it is essential to acknowledge that while the core principles of design remain constant, the complexity of applying these principles increases exponentially with the scale of teams, applications, and user needs.

Creating Interfaces at Scale

When large cross-functional teams are involved in the product development process, the array of different backgrounds, mental models, and expertise each member brings can significantly impact consistency, development velocity, and overall product quality over time. A team’s mix of skills and perspectives can be an asset, driving innovation through synthesizing varied ideas and experiences. Designers, software developers, product managers, and marketers look at problems through different lenses, often leading to a richer set of solutions. However, this diversity also challenges maintaining a unified vision and consistent application of design and development principles across the product.

As the number of products and features grows, maintaining a consistent user experience brings its own set of complexities. Consistency becomes a core foundation of design at scale to foster a coherent user experience. Additionally, when interfaces maintain a uniform design language and behave predictably, users can quickly transfer their knowledge and skills from one context to another, reducing the learning curve (Krause, 2021).

Another aspect of scalable products is achieving efficiency throughout the interface design and development process. Promoting reuse in that context is about saving time and resources and nurturing a cohesive language that can be shared by multiple teams across projects. Reusing repeated GUI elements and interaction patterns ensures that features can be rolled out faster, with fewer resources, and less risk of introducing inconsistencies that could confuse users or dilute the brand. When designers and software developers are able to draw from a shared repository of pre-designed elements, they can focus on solving new problems rather than reinventing solutions to old ones.

Successfully implementing principles of consistency and efficiency at scale requires a more strategic and structured approach — this is where *design systems* come into play.

What is a Design System?

A design system represents the convergence of the terms *design* and *system*. Charles Eames, one of the most influential industrial designers of our time, defines design as “a plan for arranging elements to accomplish a particular purpose” (Eames Office, 2013). A system is “a regularly interacting or interdependent group of items forming a unified whole” (Merriam-Webster, n.d.). The term can be subject to misinterpretation as it carries different meanings for different individuals or groups involved (Edelberg & Kilrain, 2020). Many attempts have been made to define the convergence of terminology in digital product design, given the generic nature of the term and its existence in other applications such as engineering, production, and manufacturing. Therese Fessenden (2021) defines a design system as “a set of standards to manage design at scale by reducing redundancy while creating a shared language and visual consistency across different pages and channels.” Jenya Edelberg and Joseph Kilrain’s (2020) definition highlights that a design system functions as a “guiding star” for teams involved in the design process, serving as a “single source of reference for teams to ideate, design, and develop a product.” Will Fanguy’s (2019) definition captures the modular nature of design systems as “a collection of reusable components, guided by clear standards, that can be assembled together to build any number of applications.” Figma (n.d.-a), the prominent collaborative interface design tool mentions that a design system extends to include the “entire product ecosystem” highlighting that it “provides the tools and resources to build consistent and cohesive products”. In conclusion, design systems can be viewed as a living repository of interface-related design decisions coupled with design and code artifacts to rapidly scale digital products. By capturing these decisions centrally, a design system can enable designers and developers to create consistent and cohesive products (Churchill, 2019; Edelberg & Kilrain, 2020; Lamine & Cheng, 2022). This aspect promotes cross-functional collaboration and enhances design quality (Churchill, 2019). In addition, a centralized and consistent design and implementation environment allows cross-functional teams to deliver their work efficiently by following predefined patterns and components (Lamine & Cheng, 2022).

Recognizing the strategic importance of design systems, companies like Google, Apple, and IBM have built a culture around their use and established dedicated teams focused on their development and maintenance. These specialized teams ensure that design systems continue to align with the company's evolving brand and technological advancements while supporting the delivery of best-in-class experiences to customers.

Research Motivation and Questions

In 2016, while working at the leading telecommunications company in Dubai, UAE, I encountered the challenges of creating designs for various digital touchpoints and screen sizes, from compact smartphones to expansive 120-inch touch displays. Tasked with managing our UI component library, my objective was to optimize our workflows and eliminate redundant tasks, such as designing the same button or input field repeatedly. During that time, I recognized the interconnected nature of our work — a small alteration in one component could have substantial ripple effects elsewhere. Since then, the transformative potential of design systems has become increasingly evident to me while creating, maintaining, implementing, and evangelizing them at several prominent organizations. Beyond their immediate utility in establishing consistent and efficient workflows, I have observed a significant benefit. Utilizing design systems liberates creative and problem-solving energies, allowing product teams to focus on innovation and using time and resources that might otherwise be dedicated to routine UI creation tasks.

Recognizing this significant role, my recent reflections on the changing world around us have led me to question the long-term viability of design systems in supporting digital product creation. These perspectives led to establishing the primary question of this research, which is:

In the light of ongoing technological, social, and economic changes, how will design systems transform in the year 2030 to sustain their role in supporting digital products?

In addition to the primary research question, additional secondary questions are explored:

- **What interdependencies exist in a design system?**
  A design system encompasses a complex network of technical specifications, operational workflows, and human dynamics. Understanding how they work is crucial to identify opportunity areas for potential transformation.

- **What are the external factors that can influence design systems?**
  The rapid technological evolution is starting to reshape digital product creation, and in turn, posing opportunities and challenges for design systems. In addition, economic and social factors can redefine the priorities and strategies within design systems and the organizations that employ them. Understanding these implications can help determine the direction and adaptability of design systems in the future.

- **How can design system teams prepare for an uncertain future?**
  I often reflect on the potential changes to my role and those of my design system peers, considering the ways we can prepare for upcoming changes in how we work, collaborate, and the new skills we should acquire.

Methodology

This research uses strategic foresight to answer the primary question of “how will design systems transform in the year 2030 to sustain their role in supporting digital products?” Strategic foresight as defined by Richard Slaughter (1999) is “the ability to create and maintain a high-quality, coherent and functional forward view, and to use the insights arising in useful organizational ways. For example, to detect adverse conditions, guide policy, shape strategy and explore new markets, products and services. It represents a fusion of futures methods with those of strategic management.”

The primary and secondary questions are investigated in three phases, outlined below:

Phase 1: Unpacking Design Systems

The purpose of this phase is to answer the secondary question of “What interdependencies exist in a design system?” A comprehensive literature review was undertaken, encompassing academic papers, grey literature, online reports, articles, and blog posts, to provide a historical context and in-depth analysis of design systems.

In addition, this review examined over 10 design systems listed on websites like The Component Gallery by Iain Bean (n.d.) and Design Systems Repo by Jad Limcaco (n.d.). These websites are an essential reference for the design system community offering a comprehensive list of UI components, articles, tools, and other resources. It was observed that most design systems are focused on web applications utilizing JavaScript frameworks like React and Vue.js. Other design systems, such as Google’s Material Design and Apple’s Human Interface Guidelines (HIG) provide guidance for designing for a broader stack of technologies and platforms including mobile, TV, and wearables. However, all these design systems share more similarities than differences when it comes to how they are constructed.

Stakeholder mapping: Stakeholder groups were plotted on the Power-Interest Matrix, first introduced by Aubrey Mendelow (1991), based on two key factors: their level of interest in the use and success of the design system, as well as their power to influence its continuous evolution. This matrix helps in categorizing stakeholders into four categories:

- High power, highly interested parties (manage closely)
- High power, less interested parties (keep satisfied)
- Low power, highly interested parties (keep informed)
- Low power, less interested parties (monitor)

Categorizing stakeholders helps to determine who the key stakeholders are to study their relationship with the design system and its elements and processes more closely.

System mapping: In analyzing design systems of the present, a system map was created to visualize the connections between design system elements, tools, influences, and key stakeholders. This map draws inspiration from the Actor Network Theory (ANT), a sociological theory that attributes equal significance (or agency) to both human actors and non-human actants in shaping social dynamics (Latour, 2007). ANT is commonly associated with Socio-Technical Systems (STS) where the interdependence of people, processes, and technology in organizational or systemic structures is considered (Field, 2020). By mapping out the relationship networks in a design system, this map helped identify which actors/actants hold the most influence within the system to explore their future evolution.

Phase 2: Environmental Scanning

In this phase, the external factors that can influence design systems were explored by conducting an environmental scan. Environmental scanning is a technique used in strategic foresight to identify directions of change that can affect the future. It is defined as “the acquisition and use of information about events, trends, and relationships in an organization’s external environment, the knowledge of which should assist management in planning the organization’s future course of action” (Choo, 2002). In an environmental scan, signals are systematically collected and analyzed to uncover emerging trends, innovations, or potential disruptions. Environmental scanning is an essential step that enables organizations and governments to be proactive rather than reactive, allowing them to anticipate changes and adapt accordingly.

This research project’s environmental scan was centered on identifying emerging trends in the last three years that can potentially influence the dynamics of design systems and their stakeholders. As part of this phase, a brief literature review was conducted to understand AI concepts like Machine Learning (ML) and Large Language Models (LLM), as well as Extended Reality (XR) applications to explore how they might relate to and affect design systems.

Phase 3: Future Scenarios and Recommendations

The scenario development step in strategic foresight is a crucial process where various future scenarios are explored to help organizations and individuals anticipate and prepare for a range of possible outcomes. Before scenarios are generated, key trends identified in Phase 2 were analyzed to determine their future directions. In this research, it is assumed that technology is the primary factor driving the future transformation of design systems. First, because design systems exist to support digital product creation which relies on technological advancements to

evolve. Second, technology can alter the ways in which design systems are created, maintained, and implemented through efficient and more robust tools and frameworks.
For creating future scenarios, Jim Dator’s (2009) alternative futures method was selected because it provides a foundational starting point to envision what these futures might look like. It offers an open and creative canvas to study the effects of multiple technological trends, in addition to other impactful and uncertain social and economic factors. Dator’s futures method comprises four scenarios, which are outlined below:

- ***Continuation:*** This future assumes current trends like technological advancement and economic growth will continue.
- ***Collapse:*** A scenario where unsustainable practices lead to a significant breakdown in societal, economic, or environmental systems.
- ***Discipline:*** This future envisions a society that adopts strict rules and sustainability practices, often sacrificing individual freedoms for collective well-being.
- ***Transformation:*** Characterized by radical changes and innovations, this future sees society altered by technological advances or significant shifts in social and economic structures.

After creating the scenario narratives and examining the transformations within design systems, the final phase of the research shifted its focus to developing strategic recommendations aimed at assisting design systems professionals. This guidance is intended to help them prepare for various potential outcomes and effectively manage other key stakeholders.

Phase 1: Unpacking Design Systems

Historical Context

The idea of breaking down design systems into modular and reusable components, while not entirely novel or unique to digital products, can be attributed to the concept of modular design. In this approach, products are constructed using interchangeable components, each designed for a specific function and minimal interaction, facilitating their independent design and production (Kamrani & Salhieh, 2002). Modular design has a rich and diverse history across different fields and applications.

According to the Modular Building Institute (MBI, 2021), examples of modular construction emerged in the 1600s, when a colonial American fisher, who had recently moved from England, disassembled and shipped his home by boat across the Atlantic Ocean. MBI further states that modular homes gained more traction in the late 19th century, with several companies selling hundreds of thousands of modular homes. Modular housing became increasingly popular and continued to expand through experiments and innovations in the 20th and early 21st centuries. This includes the Dymaxion House by Buckminster Fuller in the 1930s, Habitat 67 by Moshe Safdie in the 1960s, the Nagakin Capsule Tower by Kisho Kurokawa in the 1970s, and the Klip House by Greg Lynn in the 2000s (Wagner, 2016).

In graphic design, the 20th century marked the emergence of more systematic design approaches. Influenced by movements like the Bauhaus and Swiss Design, graphic designers began to adopt more grid-based layouts and typographic systems (Budrick, 2020). This period saw the birth of what could be considered early examples of design systems in print media in the form of style guides, where consistency across different elements, such as typefaces, colors, and layouts, was crucial for brand identity. In some cases, like the 1976 NASA Graphics Standards Manual (NHB 1430.2), these guidelines offered explicit usability principles for signage typography that ensured high visibility and readability (Fessenden, 2021).

In computer software, the concept of modularity took a notable leap in the mid-20th century as well. Modular software design, which involves building a software system as a suite of separate, interchangeable components, became increasingly important with the rise of complex computing systems. One of the earliest examples of modular software design was in the development of operating systems such as Unix. Developed in the 1960s and 70s (Nokia Bell Labs, 2019), Unix was designed using a philosophy of “Do one thing and do it well” (Merrill, 2009), underscoring the essence of modularity in software design.

By the late 20th century, the web revolution set new expectations and pushed companies to further enhance their interaction and user experience (UX) design (Nielsen, 2017). As websites matured in the early 21st century, the shift to Web 2.0, characterized by user-generated content, social networking, and interactive collaboration, brought the concept of pattern libraries. In their research, Yassine Lamine & Jinghui Cheng (2022) explored the historical link between design systems and design pattern libraries, as well as web front-end development frameworks such as Bootstrap, which significantly simplified responsive and mobile-first web project development in the 2010s.

As we continue to explore modern design systems in the 21st century, it is evident that Brad Frost's Atomic Design methodology was a significant influencer. Introduced in 2013, Atomic Design, inspired by chemistry, breaks down interfaces into modular basic elements (atoms) that combine to form more significant, reusable components (molecules and organisms), leading up to templates and pages (Frost, 2013). Companies like Google, IBM, and Microsoft have adopted similar methodologies as a foundation for building their mature component and pattern libraries to streamline digital product creation at scale.

The 21st century continues to witness the evolution of design systems with an increased focus on inclusivity and accessibility. Digital design systems are increasingly including guidelines for creating experiences accessible to all users, including those with disabilities — reflecting a broader shift in design from focusing solely on aesthetics and functionality to considering the social impact and design inclusivity (Putnam et al., 2023).

Design System Examples

This section offers examples of design systems employed across various sectors. It highlights similarities between different design system documentations and how they illustrate essential elements like design foundations, components, and styles. Documentation is an important aspect of a design system, offering usage guidance and explaining the underlying principles and guidelines (Lamine & Cheng, 2022).

It is important to highlight that in some organizations, brand teams typically manage their own separate documentation. This is usually different from the documentation for design systems, which is dedicated to product UI design and implementation, primarily serving the needs of product teams. For example, IBM's Design Language website (IBM, n.d.-a), distinct and separate from its Carbon Design System documentation (IBM, n.d.-b), exemplifies this division. The latter is focused on the specifics of IBM's digital product design implementation, while the former offers broader design guidance that extends to various other applications, covering brand elements like logos, photography, and illustration.

IBM Carbon Design System (Technology)

Carbon is an open-source design system by IBM, guided by the IBM Design Language and consisting of “working code, design tools and resources, human interface guidelines, and a vibrant community of contributors” (IBM, n.d.-b).

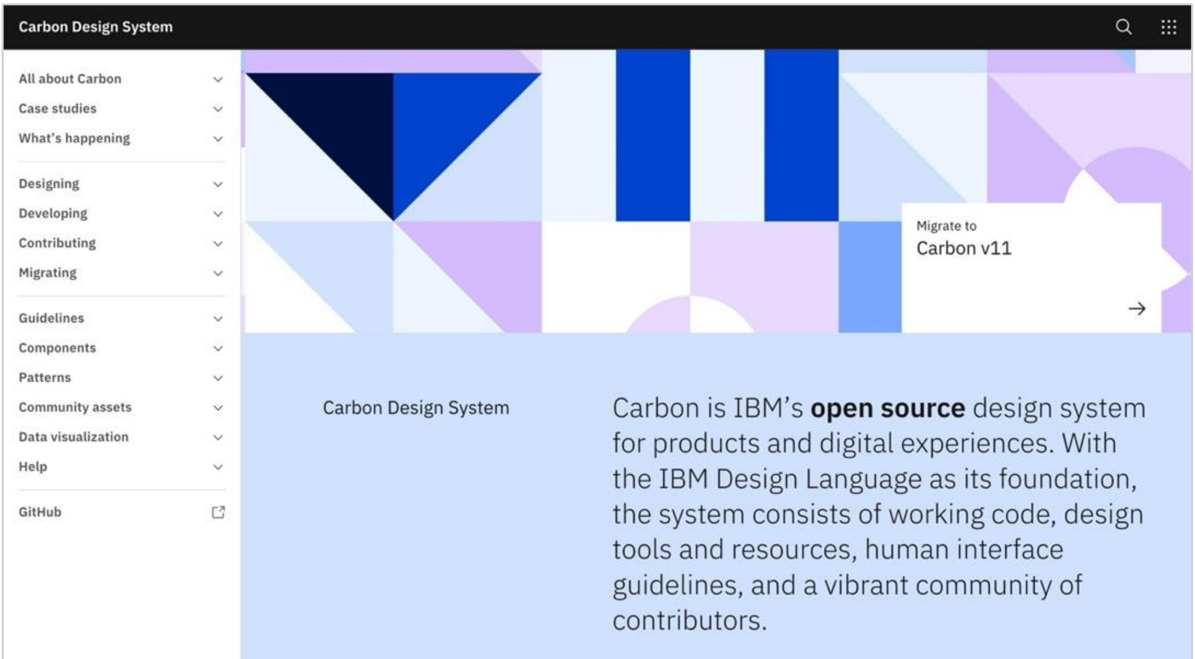

Figure 1. A screenshot of IBM’s Carbon Design System website (IBM, n.d.-b).

Carbon’s website, as shown in Figure 1, offers comprehensive documentation that includes components, design patterns, and guidelines for designing and implementing UIs. In addition, there is a dedicated contribution section where any member of the IBM product community can contribute design, code, and documentation.

Apple Human Interface Guidelines (Technology)

Apple's Human Interface Guidelines (HIG) offer tools and guidance to design applications that fit the Apple ecosystem, including platforms like iOS, macOS, watchOS, and visionOS. It is created to act as a reference for both Apple's own design and engineering teams, as well as the vibrant community of application developers.

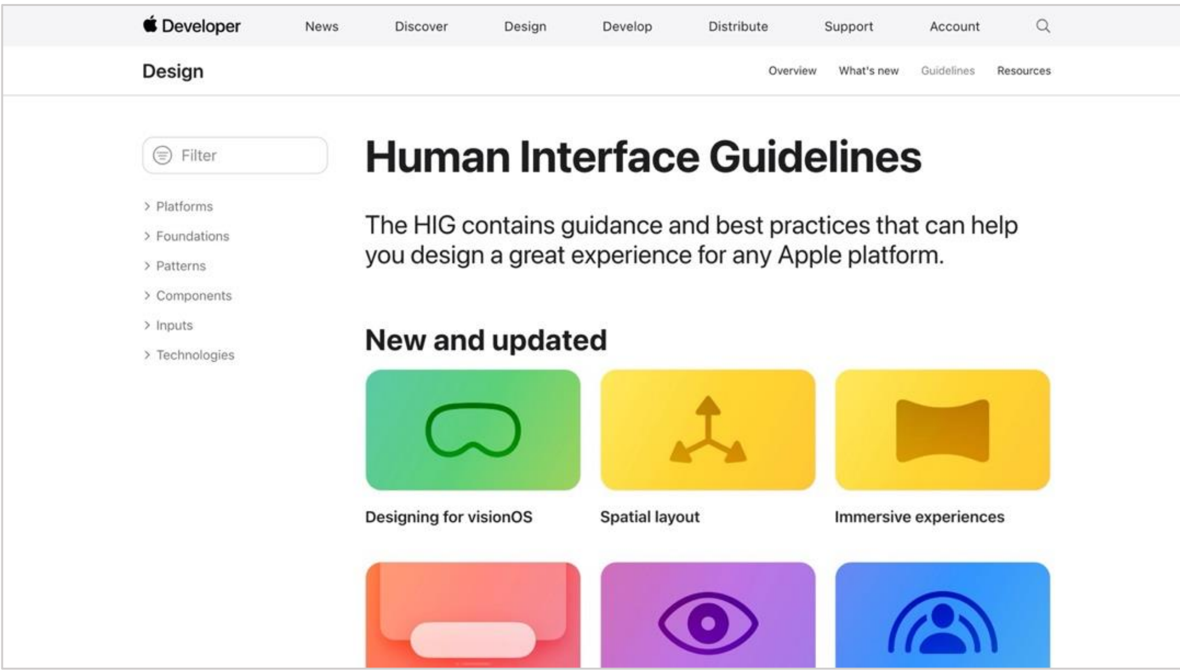

Figure 2. A screenshot of Apple's HIG website (Apple, n.d.-a).

As shown in Figure 2, designers and developers can find documentation on the HIG website for foundational elements, including color, typography, layout, and accessibility. Components and design patterns, which are core elements of a design system, have their dedicated sections, offering tactical guidance on approaching interface design and implementation successfully. Additionally, the HIG offers a dedicated section for different user input methods, allowing designers to optimize the user experience for different types of devices and interactions. Designers interested in designing for Apple platforms can download various design starter kits from the resources section.

Google Material Design (Technology)

Material Design, as defined by Google (n.d.-a), is “an adaptable system of guidelines, components, and tools that support the best practices of user interface design.”

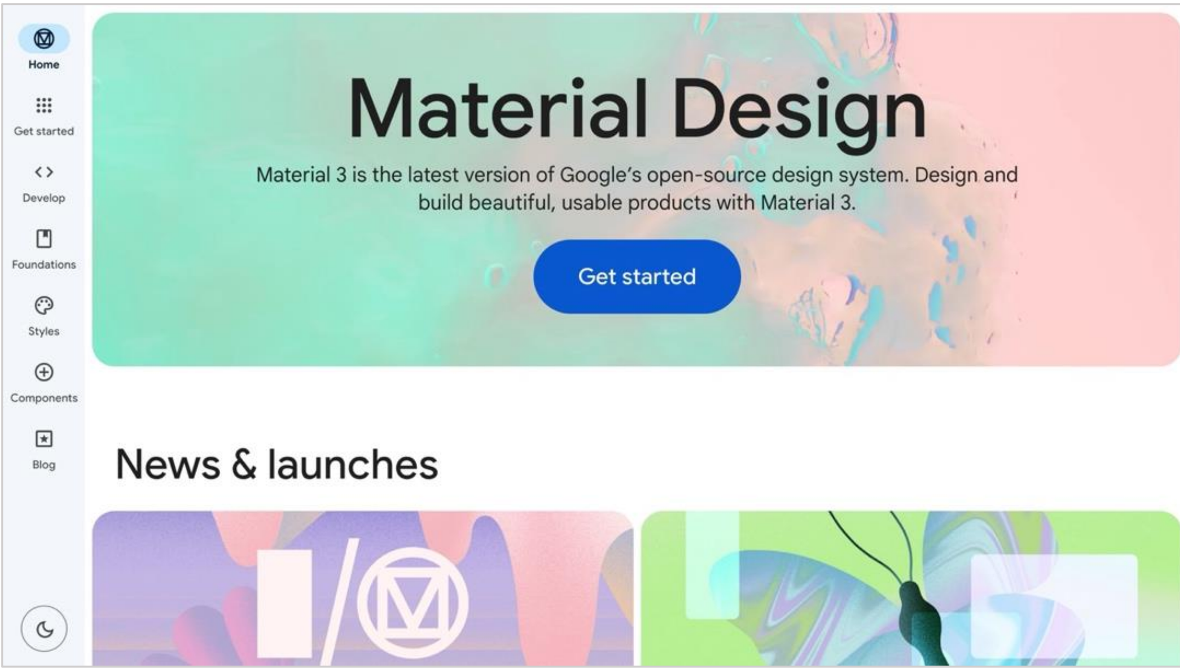

Figure 3. A screenshot of Google’s Material Design website Google (n.d.-a).

As illustrated in Figure 3, the Material Design website includes documentation for designers and developers to build applications for various platforms, including UI component implementations for Android, Flutter, and the web. Like other design systems, Material Design offers a dedicated components section with examples for actions, containment, navigation, inputs, and others. In addition, it provides a foundations section covering accessibility, content design, interaction patterns, and layout structures.

GOV.UK Design System (Public Sector)

Design systems are commonly used by governments and public sectors in Australia, Canada, USA, and several others (Taylor, n.d.). The GOV.UK Design System is a comprehensive and robust design system that helps “make government services consistent with GOV.UK” (GOV.UK Design System team, n.d.).

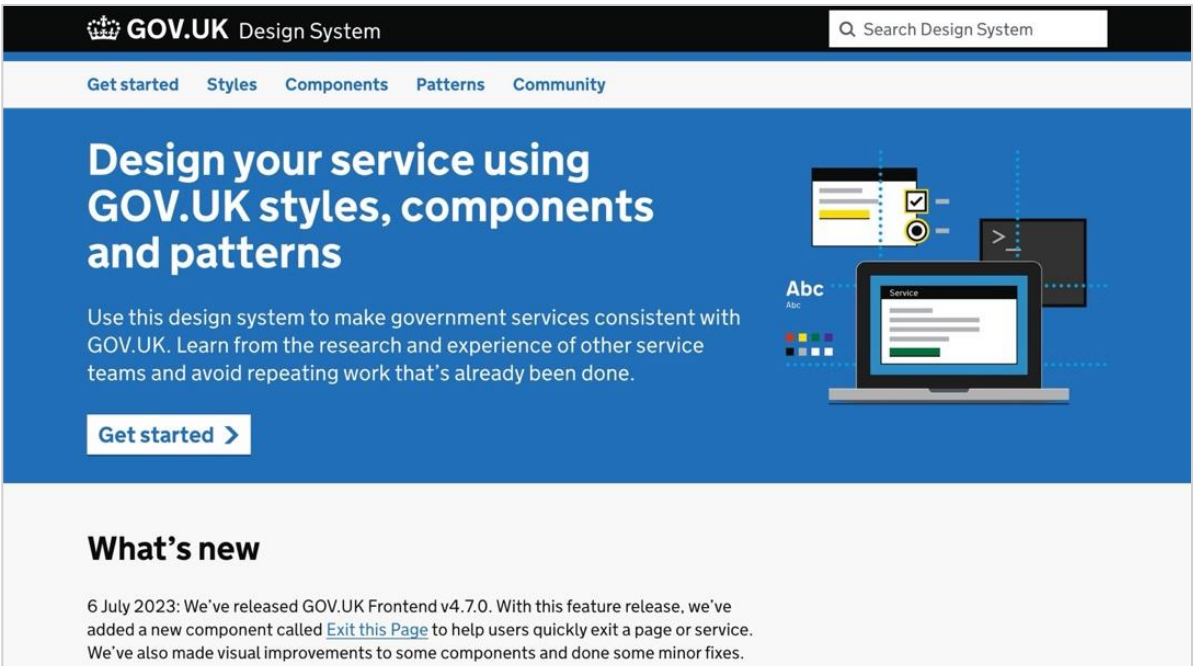

Figure 4. A screenshot of GOV.UK’s Design System website (GOV.UK Design System team, n.d.).

The GOV.UK Design System website, illustrated in Figure 4, focuses on documentation for styles, components, and patterns. The styles section offers colour, typography, layout, and spacing guidance. Like other design systems, the components section offers detailed documentation on usage and implementation for various common UI components like buttons and inputs. In addition, the patterns section offers best practices aimed at solving everyday user tasks and problems.

Porsche Design System (Automotive)

In addition to the technology and public sectors, many industries have embraced the establishment of mature design systems, aiming to expedite the creation of digital products. Porsche, the iconic German automotive company, has developed the Porsche Design System to provide "the design fundamentals and elements for efficiently creating aesthetic and high-quality web applications" (Porsche AG, n.d.).

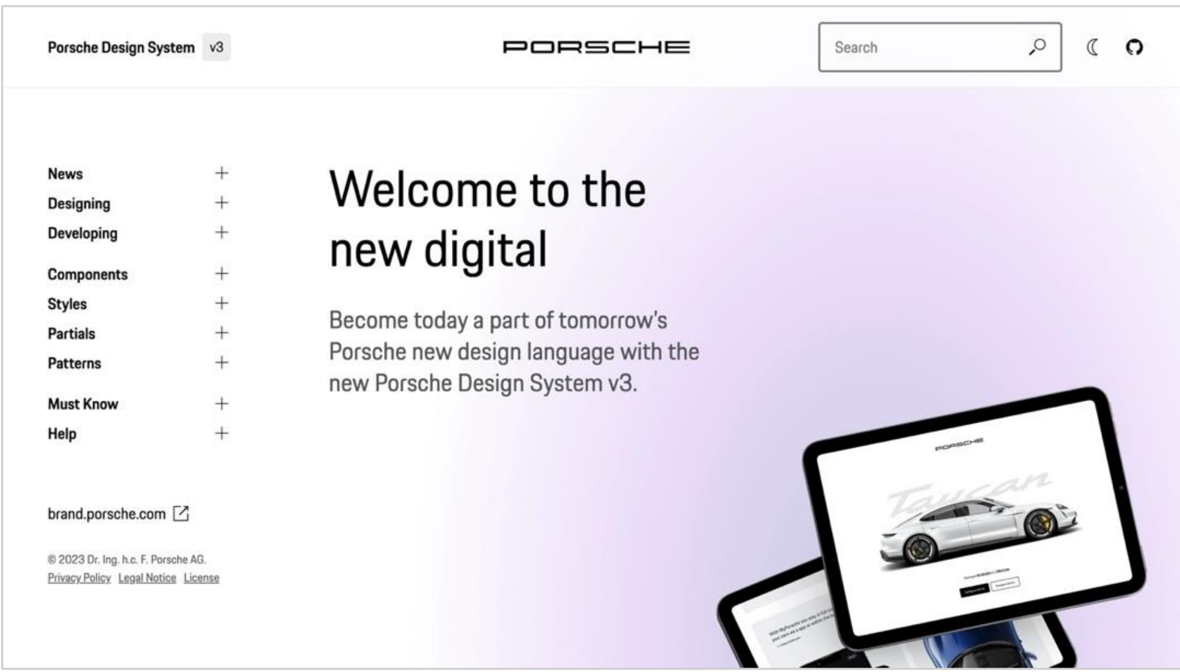

Figure 5. A screenshot of the Porsche Design System website (Porsche AG, n.d.).

The Porsche Design System documentation, showcased in Figure 5, offers a similar structure to the GOV.UK website, highlighting components, patterns, and styles. The main navigation highlights two key patterns, forms and notifications, likely due to their significance in designing digital experiences for Porsche customers. The website also offers an external link to Porsche's brand website, indicating that design system documentation is typically focused on offering guidance for product design and development.

Design System Stakeholders

Understanding the stakeholder landscape is crucial for identifying and focusing on specific groups that are significantly connected to the design system and its elements. This approach also assists in narrowing down the scope of the study to better understand the future implications for these stakeholders and how they will affect and be affected by the system.

The literature review on this topic revealed two notable design system stakeholder maps. The first map (as shown below in Figure 6), created by Jeremy Brett (2019), focuses on understanding the power and interest structures to gain support (or buy-in) for creating a design system in an organization. These stakeholders are categorized below:

- ***Makers:*** Directly manage, design, develop, document, and maintain the system.
- ***Contributors:*** Utilize the design system in their work but may not be directly involved in its core development or management.
- ***Observers:*** Have an interest in its development and impact. They are typically characterized by their passive but informed role in the process.
- ***Supporters:*** Endorse and advocate for the design system. They are crucial in driving its success by providing essential backing and resources.

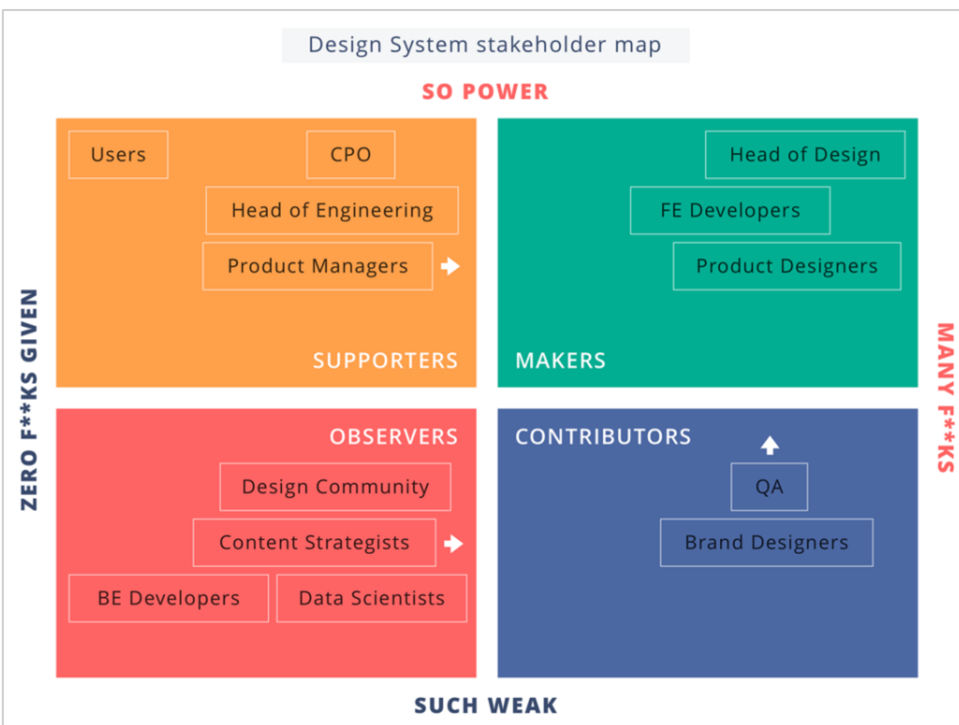

Figure 6. A design system stakeholder map that categorizes stakeholders as Makers, Contributors, Observers, and Supporters (Brett, 2019).

The second map, illustrated in Figure 7, was created by Mele Hamasaki and Jesse Spencer (n.d.) to identify and prioritize the most valuable user groups for Workday's Canvas Design System. In their map, the team presented a detailed list of "every role, team, and organization that is either impacted by Workday Canvas or has the ability to influence the system." They also conducted user research to better understand how the design system is used.

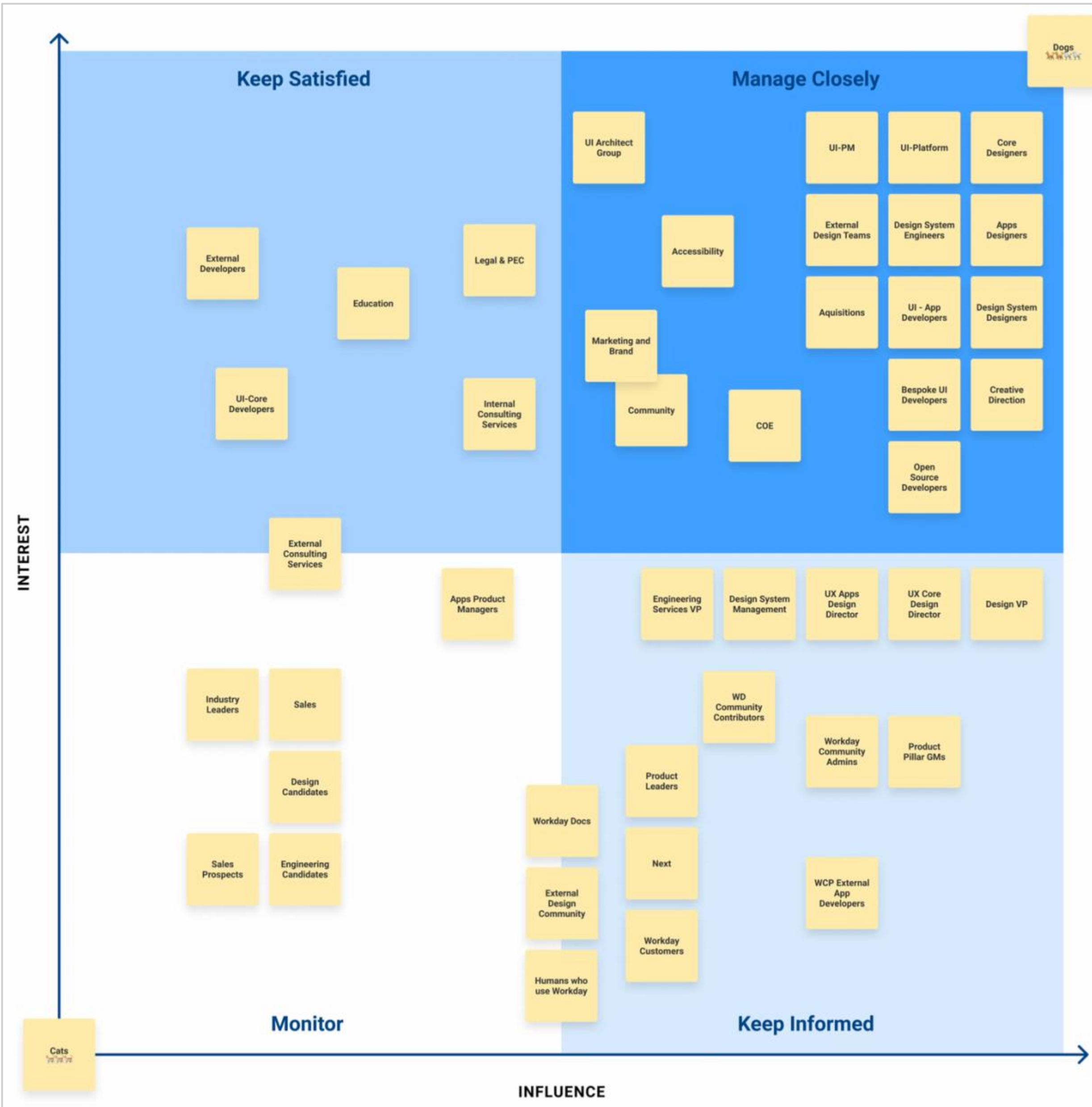

Figure 7. A detailed stakeholder map of Workday's Canvas Design System (Hamasaki & Spencer, n.d.).

The stakeholder map I created for this research, illustrated in Figure 8, draws inspiration from the two stakeholder maps previously discussed. It is created from the perspective of the core *Design System Team*, aiming to understand the range of stakeholders with whom they interact.

While this group is not plotted on the map, it still holds the highest levels of power and interest, given its pivotal role in creating, maintaining, supporting, and evangelizing the design system.

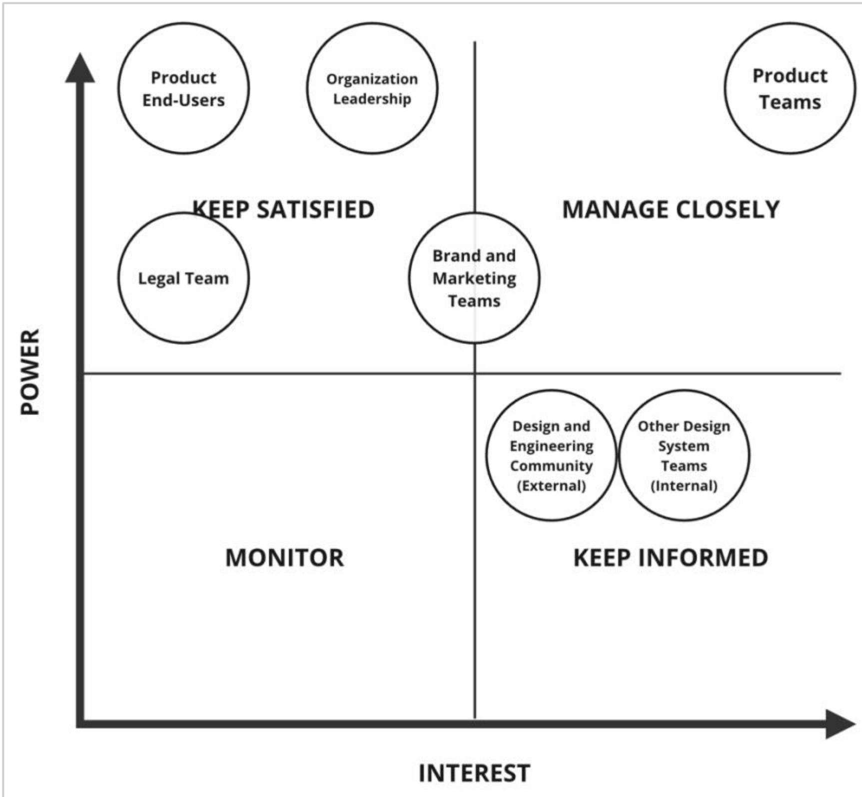

Figure 8. The stakeholder map created for my research, offering a holistic overview of the stakeholders a design system team typically deals with.

When it comes to similarities and differences with the other two stakeholder maps, the following can be observed:

- My stakeholder map uses the classic labeling from Mendelow's (1991) matrix for each quadrant. This is consistent with Hamasaki and Spencer's (n.d.) approach and different from Brett's (2019) method, which uses custom labels to describe the stakeholders' roles in the system.
- Instead of mapping individual roles, as seen in the other two maps, my map adopts a more holistic approach, where groups represent multiple related roles with common needs. This method intentionally narrows the research scope, avoiding an in-depth examination of detailed roles and individual needs. These groups are defined below:
    - ***Product End-Users:*** Individuals or groups who ultimately use the digital product. They are the target audience for whom the product is designed and developed. Their feedback and usage patterns are critical for improving and tailoring the product to meet their needs.

- ***Organization Leadership:*** This group consists of high-level executives and decision-makers. They are responsible for setting the organization's direction, strategy, and goals. Their decisions impact the long-term vision and financial health of the company.
- ***Product Teams:*** These teams are directly involved in creating product features. They include roles like product managers, software developers, and UX/UI designers. They work collaboratively to plan, design, develop, and iterate on the product, ensuring it meets the needs of the *Product End-Users* and aligns with the organization's goals.
- ***Legal Team:*** The legal team handles all legal aspects of the product and the organization.
- ***Brand and Marketing Teams:*** These teams are responsible for building and maintaining the brand's image. They develop marketing strategies, campaigns, and materials to promote the product and engage with the target audience, aiming to increase brand awareness and drive sales.
- ***Design and Engineering Community (External):*** A community of designers and engineers not directly employed by the organization but who may contribute to or influence the design system development. This community can include industry experts and members of open-source projects. Their input can provide valuable external perspectives and innovative ideas.
- ***Other Design System Teams (Internal):*** These teams maintain other internal design systems within an organization.

- Regarding the placement of *Product Teams*, all maps consistently position them in the top-right quadrant, indicating their need for close management as the primary *users* of the design system. However, Brett (2019) labels this quadrant as *makers*, reflecting how design systems are typically initiated within organizations through the efforts of *Product Teams*. *Product Teams* often continue to support the design system through ongoing contributions, and therefore, categorizing them as both *users* and *makers* remains valid.
- Placing *Organization Leadership*, including roles like the Chief Product Officer (CPO) and Head of Engineering, in the top-left quadrant aligns with Brett's (2019) approach. As key *supporters* of the design system, this group is deeply invested in its success and is likely to require continuous updates on its progress and the value it brings. Therefore, it is essential to keep them satisfied and well-informed.
- Placing the *Product End Users* in the top-left quadrant aligns with Brett's (2019) approach. This group must be kept satisfied because the entire product's success depends on their continued usage and satisfaction.
- External stakeholders, like the *Design and Engineering Community*, start to emerge when the design system is publicly accessed. The degree of interest and power depends on the level of engagement and contribution this group has. For example, in open-source design systems like Google's Material Design, external communities are more

invested in the design system because they rely on it to build and customize their products (Lamine & Cheng, 2022). Publicly accessed design systems may also require the consultation of *Legal Teams.* Therefore, this group is placed in the top-left quadrant, and their requirements must be satisfied. The placement of these two groups in my stakeholder map aligns with Hamasaki and Spencer's (n.d.) approach, contrasting with Brett's (2019) map, where the *Design Community* is placed in the low-interest and low-power quadrant.

- In larger organizations with multiple design systems managed by different teams, these additional *Internal Design System Teams* may be positioned in the bottom-right or the top-right quadrant, depending on their influence. Placement in the top-right quadrant indicates high power, suggesting shared dependencies and significant interconnectivity between internal design systems. In my map, it is assumed that this group has limited power of influence.
- Finally, the level of interest and power of *Brand and Marketing Teams* can vary depending on the organization and their proximity to digital products. From my interactions with these teams across several organizations, I have observed that they typically exhibit low to medium interest but possess a high degree of power. This power is rooted in their influential role in defining and upholding the brand's look and feel. This approach aligns more closely with Hamasaki and Spencer's (n.d.) map.

In conclusion, the stakeholder mapping activity has underscored the need to investigate the relationship between *Product Teams* and other design system elements further, given their high level of power and influence. While not plotted on the stakeholder map, the *Design System Team* will also be further studied, given their essential role as system *makers*. In addition, the impact of the *Organization's Leadership* and *Product End Users* is essential in directing the product's development and, subsequently, in determining how the design system is structured to support this direction. These key aspects will be the focus of exploration in the next section.

Design System Map

Emphasizing the importance of design systems, Nathan Curtis (2016), a leading design systems advocate, affirms that it is not merely a *project* but rather a *product* that serves other products. Like any product, there needs to be an infrastructure that ensures a design system operates successfully within an organization, including people, processes, tools, and support channels. Figure 9 represents an ANT map of the design system infrastructure, illustrating the complex relationships between different human and non-human actors.

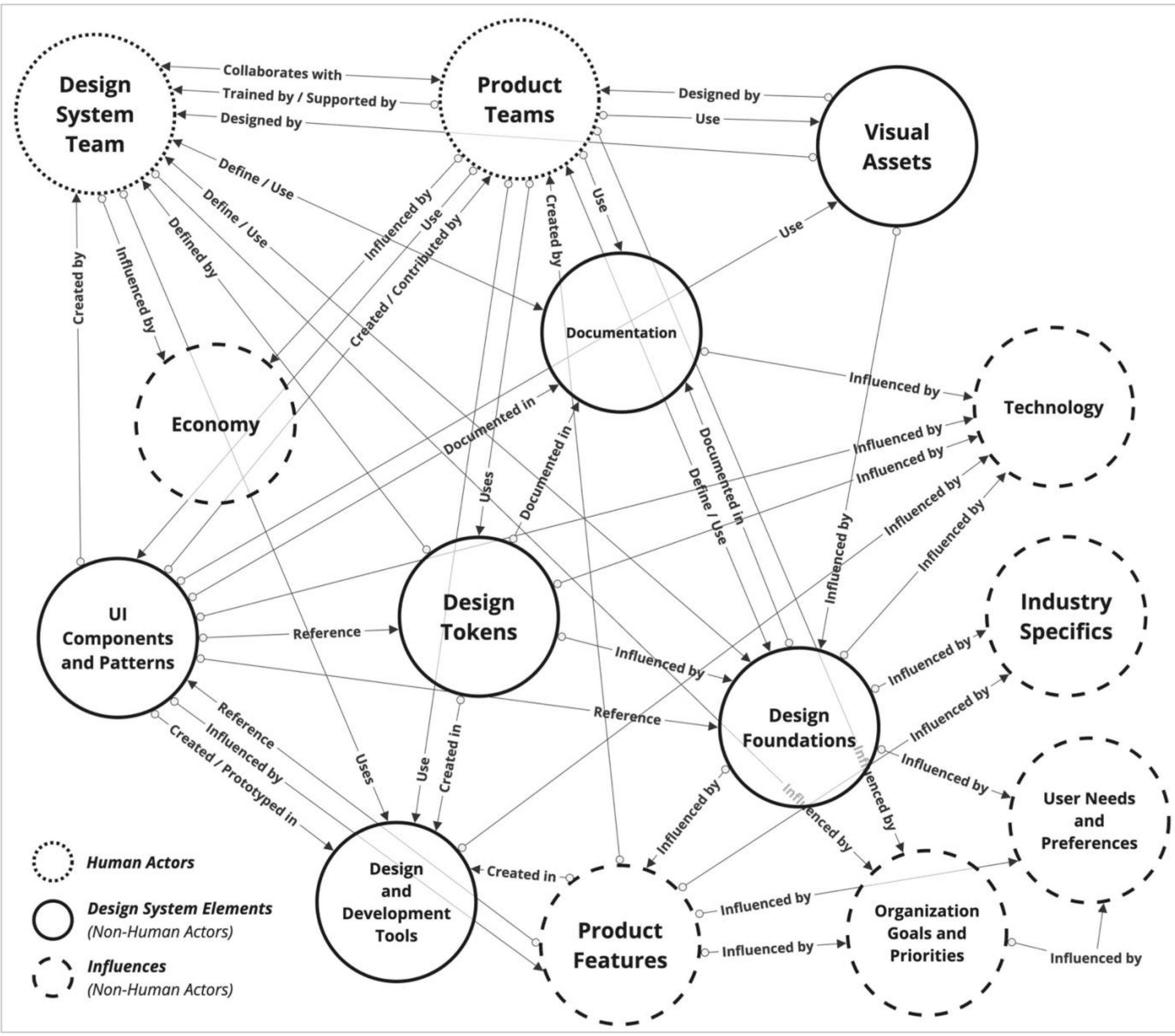

Figure 9. The design system ANT map, highlighting the relationships between its actors.

The map uses circles (or nodes) with solid, dotted, and dashed outlines to distinguish between human and non-human actors. These nodes are described below:

- ***Dotted nodes illustrating Human Actors:*** As identified in the previous stakeholder mapping activity, the primary stakeholders with significant interaction, interest, and influence on the design system are the *Design System Team* and the *Product Teams*. It is essential to study their roles, especially as design systems continue to evolve.
- ***Solid nodes illustrating Design System Elements (Non-Human Actors):*** These elements represent the infrastructure of a design system. They include *Design Foundations*, *UI Components and Patterns*, *Design Tokens*, *Visual Assets*, *Design and Development Tools*, and *Documentation*.
- ***Dashed nodes illustrating key Influences (Non-Human Actors):*** Design systems can be Influenced by many aspects like *Technology*, *Economy*, *Product Features*, and *Industry Specifics*. Stakeholders with limited or no interaction with the system, like *Product End Users* and *Organization Leadership*, are represented on the map through their influences, specifically *User Needs and Preferences*, as well as *Organization Goals and Priorities*.

The map also uses arrows with heads (triangles) and tails (circles) to connect the nodes and describe the processes and dependencies between them. The direction of the arrow determines where the dependency lies. For example, as seen in Figure 10, the arrow ends at *Design Foundations* because they represent a dependency for *UI Components and Patterns*.

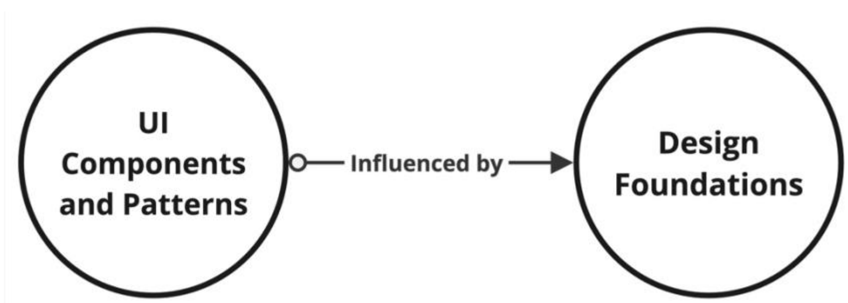

Figure 10. The direction of an arrow in the system map indicates the source of the dependency.

When arrows have heads at both ends, as seen in Figure 11, this denotes a bidirectional relationship, where influence or communication flows both ways between the connected nodes.

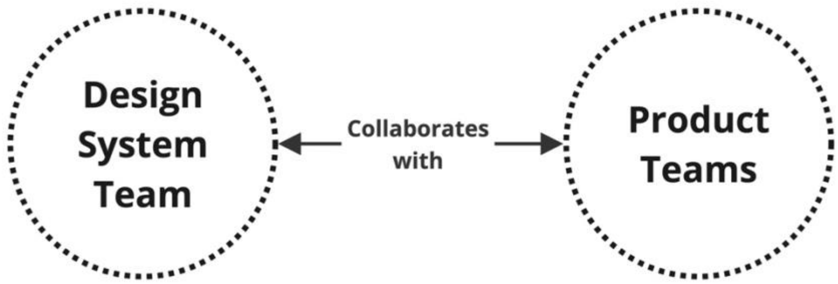

Figure 11. An example of a bidirectional dependency between two actors.

In addition, each arrow is labeled with words like *influenced by*, *defined by*, and *created by* to specify the type of interaction and dependency between nodes.

The following section will focus on unpacking each actor, highlighting its purpose, and outlining its dependencies.

Design Foundations (Non-Human Actor)

Design Foundations are the baseline of successful and well-established design systems, providing a comprehensive framework that guides interface creation across various platforms. They combine strategic and tactical best practices such as design principles, visual design elements, content design guidelines, accessibility guidance, and others. Definitions of these aspects are included in Appendix A for reference. Design Foundations may also include other guidance for design, product, or technological aspects that are tailored to an organization's approach of creating digital products. For example, Apple's HIG offers techniques and guidance for creating spatial layouts in their new XR operating system, visionOS, as part of their design foundations (Apple, n.d.-b).

Design Foundation Dependencies

- *The Design System Team typically defines Design Foundations* in close collaboration with *Product Teams* and other experts within the organization. Although the *Design System Team* might engage other departments, such as brand and marketing, in shaping some of these foundations, they are not represented on the map due to their comparatively limited interaction with the rest of the design system actors (primarily non-human). The expertise and skills of specialists in various design disciplines within the *Design System and Product Teams* are the key to shaping these foundations. Developing *Design Foundations* is an iterative and thorough process, requiring a collective understanding of the product's vision, purpose, and features among all stakeholders. One notable example is how Google's mobile operating system, Android, supported system-wide color palettes in version 12 (Krasnoff, 2021). This was enabled by their Material 3 design system's color foundations and design tokens, which adapt the user's apps to a colour of choice (Google, n.d.-b).

- Design Foundations are usually rooted in understanding *User Needs and Preferences* to determine the applicable design approaches.
- Design Foundations are influenced by *Product Features*, *Technology* stack, and *Industry Specifics* tailored to the organization. For instance, the *Design Foundations* for a smartphone shopping app, focusing on touch interfaces and mobile usability, differ from those for a VR-based interactive media player, which would emphasize immersive interaction, 3D navigation, and hand gestures.
- *Design Foundations* are documented in the design system *Documentation* as a reference for *Product Teams* and other interested stakeholders.

UI Components and Patterns (Non-Human Actor)

UI Components are the reusable building blocks of design systems, typically appearing in the form of graphical elements that facilitate user interaction with digital products. *UI Components* like buttons, input fields, and data tables (as shown in Figure 12) embody a modular approach where each component is dedicated to a specific purpose and contains attributes that offer *Product Teams* the flexibility to modify the component's appearance, content, and functionality.

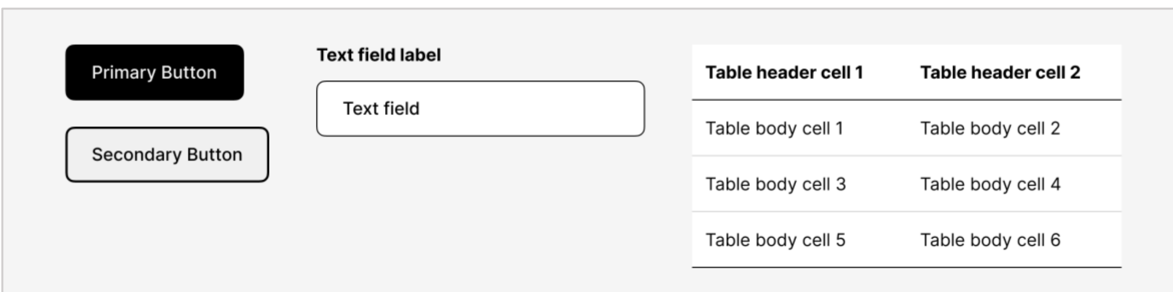

Figure 12. Examples of UI components including buttons, a text input field, and a data table.

Using the same component library, *Product Teams* can achieve high consistency across the product (UXPin, 2023). However, *Product Teams* may handle the same interaction use case differently, often resulting in an inconsistent user experience. For example, one team might utilize a dialog component to create a new record in a data grid, while another team could prefer a side panel component for the same purpose. Such inconsistencies can gradually affect the user's mental model, hinder product usability, and lead to confusion or frustration.

To help mitigate these issues, we can turn to *Design Patterns*. They are best-practice solutions to recurring design challenges, often represented as collections of *UI Components* assembled in a particular layout and flow (IBM, n.d.-c). Examples of design patterns from IBM's Carbon

Design System, as illustrated in Figure 13, include login experiences, searching, empty states, and notifications.

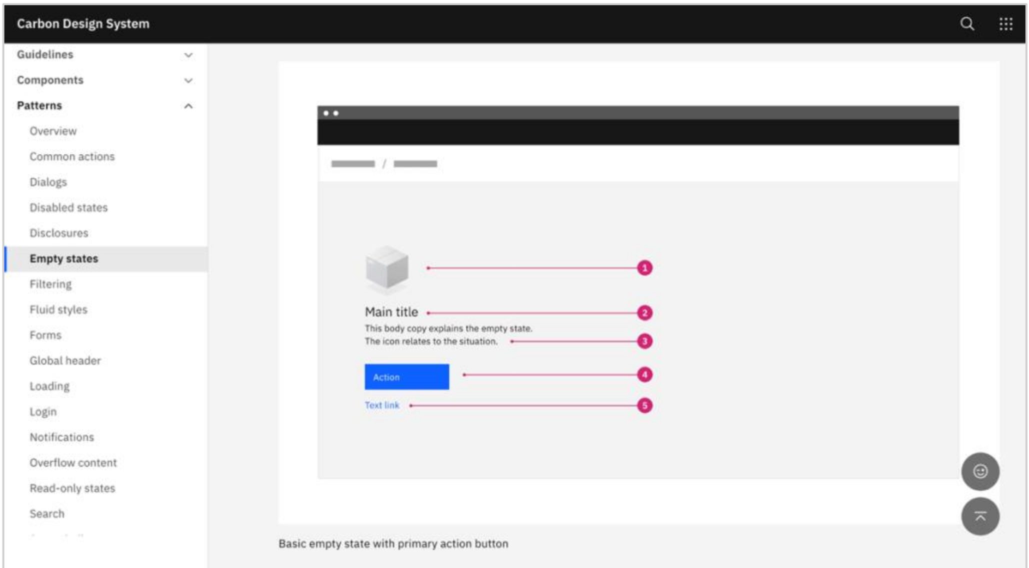

Figure 13. An example from IBM's Carbon Design System, showing an empty states design pattern (IBM, n.d.-d).

UI Component and Pattern Dependencies

- The *UI Component and Pattern* creation process is largely attributed to the *Design System Team* as the primary makers of the system. However, contribution models often exist to promote collaboration and allow *Product Teams* to participate in the UI creation process (Curtis, 2022). Making *UI Components and Patterns* is a manual and lengthy process that includes activities such as auditing existing interfaces, designing, prototyping, coding, documenting, and testing (See Appendix B for an in-depth coverage of the component creation process). The duration of each activity can increase significantly with feature complexity or accessibility requirements, especially when involving multiple stakeholders across the organization.
- *UI Components and Patterns* are created and prototyped in *Design and Development Tools*. Several tools have contributed to automating and reducing the time spent on some aspects of the creation process. Examples of such tools will be covered in more depth in a future section of this chapter.
- *UI Components and Patterns* reference *Design Foundations* to ensure consistent application of the organization's design language. This includes *Design Tokens*, encapsulating the visual characteristics of a product like color, typography, and spacing. *UI Components and Patterns* may also use *Visual Assets* like logos, icons, and illustrations that strengthen the brand identity.

- Like *Design Foundations*, the *Technology* used, *Industry Specifics*, and *Product Features* all play an essential role in defining how *UI Components and Patterns* take shape. For example, *UI Components and Patterns* created for web applications can vary from those created for a smartwatch in terms of their size, functionality, and the type of information they display. In these scenarios, the definition of cross-platform *UI Components and Patterns* emerges as a critical aspect of effective design systems within large-scale organizations.

Design Tokens (Non-human Actor)

Design Tokens are key-value attributes that represent visual design decisions, including color, typography, spacing, elevation, and animation. They are an essential aspect of *Design Foundations*. Many design systems, such as Google's Material Design or the GOV.UK Design System, refer to them as styles, because they are concerned with the stylistic aspects of the product. They are typically technology-agnostic, often created using JavaScript syntax (as illustrated in Figure 14), allowing *Product Teams* to reference them easily in design and code.

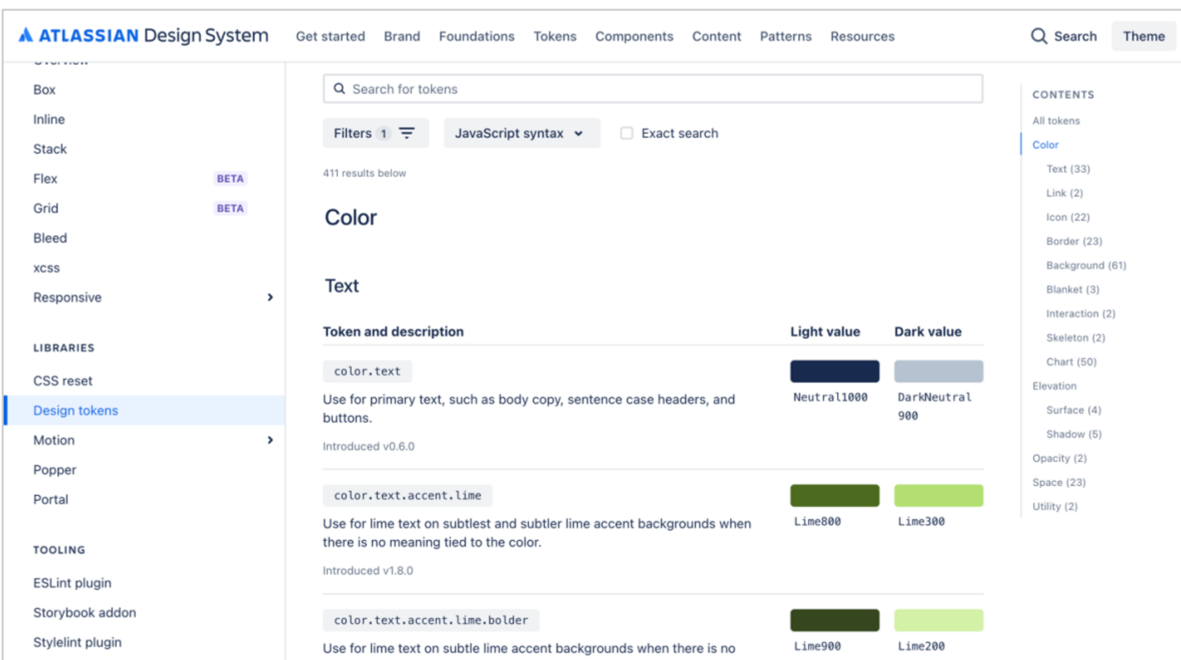

Figure 14. An example of color tokens using the JavaScript syntax from Atlassian Design System (Atlassian, n.d.-a).

Design Tokens are essential in driving visual consistency across UIs when integrated into *UI Components and Patterns*. By separating the visual layer from functionality, *Design Tokens* facilitate the creation of multiple themes. These themes enable the use of the same *UI Component and Pattern* library by multiple products or brands, allowing significant alterations in the look and feel of products (as illustrated in Figure 15). Additionally, they serve important functional purposes, such as improving accessibility and user comfort. Many design systems offer high-contrast or dark mode themes that can be dynamically switched according to user preferences or system settings, further enhancing the product's usability.

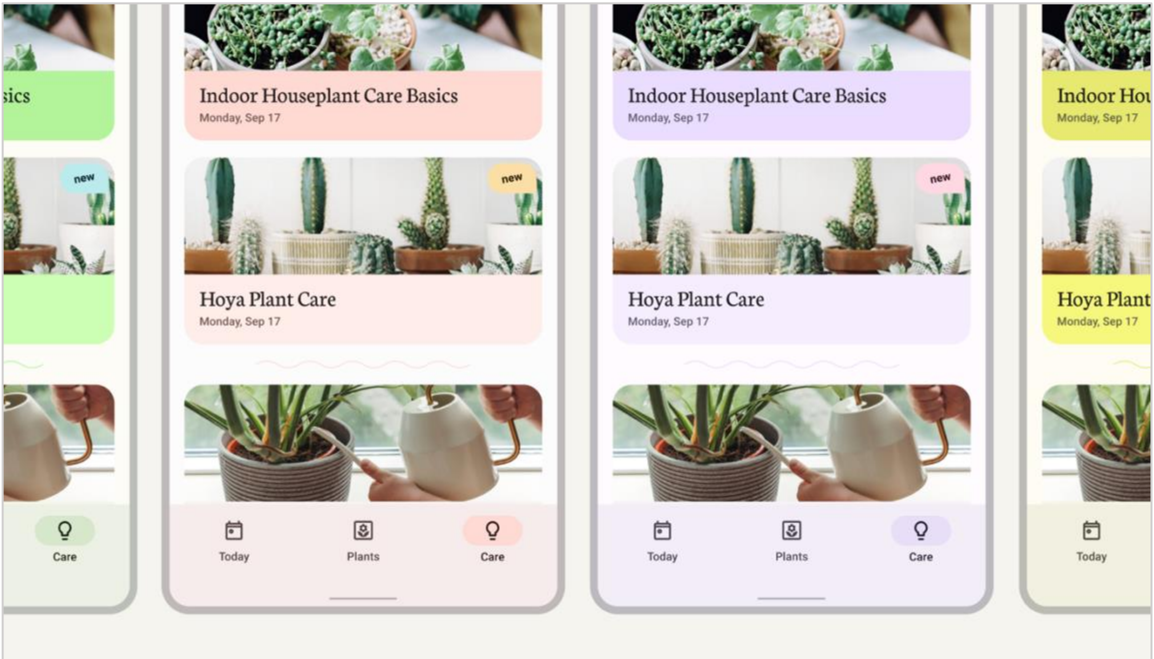

Figure 15. An example of the same set of UI components with different color themes applied from Google's Material Design System (Google, n.d.-b).

Design Token Dependencies

- Defining *Design Tokens* is a detailed process, as illustrated by Nitish Khagwal (2023) in his beginner's guide for creating *Design Tokens*. It is often attributed to the *Design System Team*, involving a thorough analysis of the component library and the rest of the product to map use cases for various visual aspects, such as color, typography, spacing, and motion. This complexity is further heightened by accessibility considerations, where ensuring legible color contrast and other accessibility factors necessitate rigorous testing for accurate token definitions. Additionally, addressing platform variability, theming, and component variations contribute to the overall complexity of the process.
- *Design Tokens* are considered a foundational layer, as seen in Google's Material Design System (Google, n.d.-a), and therefore, they are influenced by the *Design Foundations'* visual language.
- Although they can be technology-agnostic, specific platforms, like native mobile applications for iOS and Android, may need dedicated sets of *Design Tokens* to accommodate specific use cases. In such cases, adapting design tokens requires *Technology* context and awareness for successful implementation.

- *Design Tokens* are created in *Design and Development Tools* and documented in the design system's *Documentation*, which is the central source of truth. In larger design systems with a complex design token structure, *Product Teams* may encounter difficulties when referencing the appropriate design token for their work. Companies like Atlassian have addressed this challenge by developing custom tools, such as the Atlassian Design Tokens Figma plugin, to assist designers and developers in selecting the precise token for their specific use cases (Atlassian, n.d.-b).

Visual Assets (Non-Human Actor)

Visual Assets are a collection of graphical elements that strengthen the brand identity and enhance usability in digital products. They are an extension of the visual design foundations and include artifacts like logos, icons, illustrations, images, and videos. By hosting these assets centrally, *Design System Teams* can ensure consistency when *Product Teams* reference them.

Visual Asset Dependencies

- Creating *Visual Assets* is often managed by visual designers in the *Design System and Product teams*, following design and brand guidelines tailored to asset creation. *Design System Teams* typically capture these guidelines as part of the visual design foundations to reflect decisions that relate to a product. The creation process is primarily manual and dependent on human actors if assets are to be created from scratch. In many organizations I worked at, creating assets from scratch was often attributed to establishing a form of originality. However, it comes with an added cost of having dedicated practitioners in illustration, graphic design, animation, and photography. Many organizations rely on external agencies or pre-made asset libraries to speed up the creation and adoption process.
- Creating and using a consistent asset library requires the presence of *Design Foundations*, as previously highlighted. In the absence of human actors dedicated to creating these assets within the ecosystem, foundations can enforce brand consistency, especially when assets are purchased or outsourced to external agencies.

Documentation (Non-Human Actor)

Design system *Documentation* represents the single source of truth for offering guidance on using the system and its various elements. As previously discussed in this chapter, many prominent organizations rely on *Documentation* to showcase their approach to UI design, offering a reference to both internal and external teams.

Documentation Dependencies

Documentation is typically managed by the *Design System Team* and often requires content management systems (CMS) either built in-house or offered through third parties like Contentful (Contentful, n.d.). Platforms like zeroheight (zeroheight, n.d.) and Supernova (Supernova, n.d.) emerged recently to streamline the *Documentation* creation and management process, offering integration with *Design and Development Tools* to sync *UI Components* and *Design Tokens*. As these platforms evolve with *Technology*, *Documentation* can become more automated, consistent, and useful.

Design and Development Tools (Non-Human Actor)

Design Tools have evolved over the years to support the creation of digital products. In the last decade, tools like Figma (Figma, n.d.-b) and Sketch (Sketch, n.d.) have become increasingly popular among product designers, now widely regarded as the standard for UI and UX design (Stevens, 2023). In addition, these platforms continue to be pivotal in supporting the creation and evangelism of design systems. Integrating *UI Component* libraries into *Design Tools* enables *Design System Teams* to standardize and promote their systems within *Product Teams*. Figma, in particular, leads the way in introducing innovative features like *variables*, which significantly simplifies the creation of reusable themes and the generation of design tokens (Oppermann, 2023). Figma and Sketch are designed to support community plug-ins to expand their functionality further. Many of these plug-ins offer automated workflows and integrations that streamline the process of creating *UI Components and Patterns*, *Design Tokens*, and *Documentation*.

Shifting gears to *Development Tools*, we can see a broad range of capabilities for building digital products and design system features, from streamlined coding environments and cloud-based version control to advanced debugging and testing functionalities. They are instrumental in supporting various platforms, including mobile, desktop, and emerging technologies.

Design and Development Tool Dependencies

The evolution of *Technology* significantly influences the progression of *Design and Development Tools*. There is a growing opportunity for these tools to assist designers and developers in working more efficiently and collaboratively, allowing them to concentrate on the critical aspects of product development. As *Technology* continues to advance, new digital products will surface, necessitating the creation of even more sophisticated tools to enable these innovations.

Product Teams (Human Actor)

As previously defined in the stakeholder mapping activity, *Product Teams* are directly involved in creating product features, ensuring they meet user needs and align with the organization’s goals. For a design system to fulfill its purpose of promoting consistency across products and facilitating efficient workflows, it must be adopted by *Product Teams* throughout the creation of product features.

Product Team Dependencies

- *Product Teams* use *UI Components and Patterns*, *Visual Assets*, and *Design Tokens* to create consistent and high-quality UIs for the product's feature development.
- *Product Teams* require guidance to use and implement the design system using *Design and Development Tools*. This can be achieved synchronously by receiving support and training from the *Design System Team* or asynchronously through the design system *Documentation*.
- *Product Teams* rely on *Design and Development Tools* to create product features for various technologies and platforms.
- *Product Teams* and the organizations they are part of are influenced by *Economic* factors that can affect their priorities and decision-making processes.

Product Team Needs

- *Product Teams* require a continuously evolving design system to keep pace with the product. This necessitates ongoing collaboration with the *Design System Team* to ensure they are up-to-date with new requirements and needs.
- The design system should be easy to understand and use by *Product Teams*. Designers and engineers should find it straightforward to determine when to apply the correct *UI Component or Pattern* when creating product features. This necessitates prompt guidance and support from the *Design System Team*, along with accurate, up-to-date, and easy-to-understand *Documentation*.
- While consistency is critical, *Product Teams* need the flexibility to customize *UI Components and Patterns* to meet the specific needs of their products. The *Design System Team* should balance consistency and flexibility when creating *UI Components and Patterns* (Metcalfe, 2022).
- The design system should be well integrated within *Design and Development Tools* to support efficient workflows and faster hand-off between designers and engineers.

Design System Team (Human Actor)

Therese Fessenden (2021), emphasizes that "a design system is only as effective as the team that manages it." At this stage in the research, it should be apparent that the presence of a dedicated *Design System Team* can significantly benefit an organization. This is achieved through their advocacy for consistency and efficiency in workflows related to system's creation, maintenance, and support. Like other stakeholders in the system, this team also has dependencies that need to be optimized to ensure their continued success.

Design System Team Dependencies

- The team collaborates closely with *Product Teams* to understand their needs around creating digital product features and overall system use.
- The team relies on *Design and Development Tools* and features catered to design systems to create the various artifacts previously covered.
- Their work is influenced by the *Organization's Goals and Priorities*, which shape digital products and, in turn, impact the features of the design system.
- They are Influenced by the *Economy*, which can significantly impact the priorities and resource allocation within organizations.

Design System Team Needs

- There is a need for more sophisticated *Design and Development Tools* to automate repetitive and time costly tasks. This is crucial for scaling the system efficiently and providing effective support to stakeholders, allowing the team to focus on more strategic initiatives and creative problem-solving.
- The team requires continuous organizational support and investment. This ongoing commitment is essential for the team's sustained growth, adaptation to changing digital landscapes, and ensuring they are well-equipped to meet future challenges.
- There is a need for a well-considered balance in resource allocation, considering the maintenance efforts, time availability, and the scale of digital products.
- The team needs to be actively involved in organizational and product planning. This involvement is critical for aligning the team's work with the *Organization's Goals and Priorities* and ensures a more cohesive approach to digital product development. Their active participation in strategic discussions is essential for integrating their expertise and insights into the broader vision and direction of the organization's digital capability.

Summary of Phase 1

The first phase of the research provided a detailed examination of design systems, covering their key stakeholders, elements, and the interdependencies among them.

It started by discussing the historical context of design systems and similarities to modular design and its use in various fields, including construction, graphic design, and software development. The phase then delved into the emergence of web design systems, emphasizing the role of pattern libraries and frameworks in simplifying web development.

Several examples of design systems in different sectors were discussed, including prominent examples from IBM, Apple, Google, and others. These systems demonstrate the importance of documentation in explaining principles, guidelines, and usage of design elements.

The phase also addressed the role of various stakeholders in design systems, presenting different stakeholder maps to understand their influence and interest.

Following this, the phase continued with a detailed analysis of the design system map and its actors. It included a breakdown of non-human actors like *Design Foundations*, *UI Components and Patterns*, *Design Tokens*, *Visual Assets*, and *Documentation*, and human actors like *Product Teams* and the *Design System Team*. Each actor's dependencies, needs, and roles in the design system were explored.

Lastly, the phase concluded with an emphasis on the dynamic nature of design systems, the importance of continuous collaboration between teams, and adaptation to evolving technologies and user needs. It underscored the crucial role of the *Design System Team* in actively managing and evolving the system to meet organizational goals and user expectations.

Phase 2: Environmental Scanning

After closely examining design systems in the previous phase and understanding the interdependencies among their actors, the research will now shift focus to explore emerging trends and external factors that could impact and define the future of design systems. A trend is a broad pattern of change that has the potential to disrupt the future. Each trend is identified based on multiple signals that capture emerging phenomena. In this phase, five trends are identified and explored, along with their potential implications on digital product creation and the spectrum of roles that operate within it.

1. Big Tech Players Make Big Bets on Extended Reality

Extended Reality (XR) is a holistic term covering a spectrum of technologies that merge the physical and virtual worlds, including Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) — offering varying degrees of immersion and new methods of interaction. XR represents a significant advancement from traditional flat displays used in TVs, computer monitors, and smartphones, creating new, multi-dimensional experiences that are more interactive and engaging.

The rise of remote work and the reduction in in-person communication caused by global events like the COVID-19 pandemic have further accelerated the need for XR technologies. With more people working and interacting remotely, there has been a surge in demand for more immersive ways to communicate and collaborate (Jones, 2021). For example, Grundfos, a global water technology company, utilizes the SynergyXR platform for VR training to streamline employee onboarding and learning processes of their pump systems while significantly saving travel costs (SynergyXR, n.d.).

The smartphone market saturation has also led several technology companies to accelerate their innovation in XR, resulting in the rapid development of wearable technologies. A significant milestone in the XR landscape is Facebook's rebranding to Meta, signaling a deep commitment to the development of the Metaverse. The Metaverse envisions a fully realized digital world where users can interact, play, work, and learn, creating a new paradigm for social interaction (Meta, 2021). Additionally, Apple's entry into XR with the development of its MR headset, Vision Pro, further demonstrates the industry's commitment to these technologies. Building on earlier efforts by companies like Google with their Google Glass (Leswing, 2023), Vision Pro aims to offer a more refined and integrated MR experience that creates new immersive possibilities for the Apple ecosystem. It is exciting to anticipate how Apple will transform the wearable scene, especially considering its history of revolutionizing software applications since the launch of the App Store in 2008.

Signals

- Mark Zuckerberg introduced Meta in 2021, rebranding Facebook to focus on the metaverse, aiming to enhance social interactions and business growth through VR and AR (Meta, 2021).
- Meta collaborates with 15 universities in the US and introduces dedicated education shelves in the Meta Quest store, utilizing VR and AR technologies to revolutionize educational experiences (Clegg, 2023).
- Apple announced Vision Pro, a spatial computer blending digital and physical worlds using visionOS and featuring advanced display and intuitive controls (Apple, 2023).
- Apple's iPhone 15 Pro introduces a spatial video feature, creating 3D videos viewable on the upcoming Vision Pro headset, emphasizing Apple's push into advanced AR and VR capabilities (Stein, 2023).
- Morpheus XR simplifies enterprise collaboration and training in VR by providing a comprehensive solution that integrates hardware, software, and services, including headset rental and support, facilitating effective virtual interactions and personal connections (Sag & Moorhead, 2023).
- Samsung, Google, and Qualcomm (known as the XR Alliance) have rebooted their mixed reality headset project, now targeting a late 2024 release with enhanced specifications to compete with Apple's Vision Pro (Hiner, 2023).
- Apple admits to a smartphone market slowdown ahead of the iPhone 15 debut, facing challenges in a declining US market despite introducing new features (Gurman, 2023).

Implications

As XR developments progress, they have the potential to reshape industries and create a new spectrum of applications. The possibilities are endless, considering how the physical world currently constrains us and what we can do with the objects in it. The evolution of XR will echo the transformation brought by the iPhone, which opened up a world of new possibilities, far exceeding the capabilities of other phones with physical dial keys or keyboards. There is a similar leap forward with XR, suggesting a future where our interaction with technology and our environment will be redefined.

Companies like Apple and Meta have already started defining guidelines and tools for spatial design as part of the design systems. Apple's pattern library has been updated to include specific guidance for visionOS, their new spatial operating system (Apple, n.d.-b). While Meta has developed a 3D prototyping program to assist designers in creating immersive AR and VR experiences for the Meta Quest wearables. This program enables designers to consider various spatial design elements, such as object proximity and embodied interactions, and translate them into tangible virtual artifacts (Rebecca C. et al., 2023). This presents an exciting opportunity for product and design system teams to experiment with XR technologies, imagine new possibilities, and pioneer future spatial standards.

The rise of XR will necessitate a robust cross-platform strategy to support the significant increase in the scale of application development. Product teams will be tasked with creating applications that work seamlessly across websites, smartphones, and new types of advanced wearables to ensure a consistent user experience for their customers. This expansion in app development will create many new job opportunities where XR-related skills will be pivotal to successful implementation. The surge in demand for XR-related skills will influence educational curricula and professional training programs to bridge skill gaps between workers.

The expansion of XR will also contribute to an increase in remote work opportunities. However, this is likely to be met with challenges from governments and businesses in cities struggling with the economic and social implications of a workforce less tied to physical office spaces.

Lastly, XR advancements can create a digital divide, heightened by the high cost of XR technologies in early development. The early stages of XR adoption may create a gap between those who can afford to leverage these cutting-edge tools and those who cannot. Addressing this divide will be crucial to ensure that the benefits of XR are widely distributed and not just limited to a privileged few.

2. Generative AI Raises Digital Capability

Generative AI (GenAI) is a type of AI technology that uses machine learning to generate diverse and original content, including text, images, and videos, mimicking human-like outputs. Machine learning relies on neural networks, a method that “teaches computers to process data in a way that is inspired by the human brain” (AWS, n.d.).

Introducing mainstream AI chatbots like OpenAI’s ChatGPT and Google’s Bard has opened the door to widespread Large Language Model (LLM) access, an advanced type of neural network. Kim Martineau (2023), an author on the IBM Research Blog, highlights that LLMs have been transformative in their ability to adapt to different contexts, including “learning grammar of software code, molecules, natural images, and a variety of other data types.”

Following these advancements, people are now becoming accustomed to engaging with AI for various needs, from simple queries to complex problem-solving, which has significantly raised the bar for automated assistance. Responding to these growing customer expectations, many organizations in different consumer and business sectors are now offering AI-powered capabilities in their applications and services to streamline redundant tasks, personalize experiences, and assist decision-making.

Signals

- Workday announced new GenAI capabilities aimed at enhancing human performance in the workplace, focusing on productivity, talent growth, streamlined processes, and improved decision-making across its finance and HR applications (Workday, 2023).
- Okta introduced Okta AI as a powerful, data-driven platform to enhance security, developer capabilities, and policy actions, reflecting the company's ongoing mission to connect people with technology (McKinnon, 2023).
- Salesforce is set to introduce Einstein Copilot, a comprehensive GenAI chatbot, designed to automate key customer workflows and interactions across its suite of applications, promising a seamless integration for improved productivity and user engagement (Sayer, 2023).
- Spotify is using Google's LLMs to analyze user listening habits and provide personalized recommendations for podcasts and audiobooks, as part of an expanded partnership with Google Cloud (Mukherjee, 2023).
- Nearly three-quarters of UK financial services firms are piloting GenAI, primarily for internal efficiency improvements, with a focus on productivity and operational effectiveness, and risk management (Finextra, 2023).

Implications

GenAI's strength lies in its ability to generate novel things, as compared to traditional AI which focuses on executing specific tasks with predefined inputs (Marr, 2023). As more organizations and customers recognize the innovation and effectiveness GenAI, there will be a continuous need to incorporate more GenAI-driven features in products and services. This demand can extend beyond simple automation to more sophisticated tasks like data analysis and end-to-end customer service.

Companies will continue to invest in specialized teams dedicated to integrating GenAI into existing systems, developing fine-tuned solutions, and staying up to date on advancements in AI technology. This increased demand in the AI workforce will create more career opportunities for AI ethics specialists, prompt engineers, and advanced AI researchers.

Product teams working on digital products will have to evolve and broaden their skill sets to include knowledge in AI and machine learning. Design systems will play a key role in shaping AI design foundations that can establish consistent and ethical application of robust AI solutions.

3. AI-Powered Design and Digital Creation Tools Take Off

The emergence of AI-powered design and digital creation tools is altering the professional landscape in fields such as content creation, art, design, and software development. Several tools are starting to include advanced GenAI capabilities to enhance routine tasks, foster creativity, and aid in problem-solving. These developments are transforming AI's role in the workplace from a passive tool to an active co-creator. They are also enabling individuals without formal training or extensive experience to produce high-quality work. Adobe, for example, is expanding the accessibility of tools like Photoshop, traditionally used by creative professionals, under the tagline "Everyone can Photoshop" (MacLeod, 2023). GenAI also facilitates development approaches that require minimal or no coding, simplifying product customization and creation for both business technologists and citizen developers (Perri, 2023). This democratization shift is creating a more inclusive and diverse creative landscape, welcoming a broader range of voices and talents.

Signals

- Adobe introduced Firefly, a new family of creative GenAI models, starting with image and text effect generation, which will be integrated into its various cloud services to generate high-quality content quickly and easily (Adobe, 2023).
- Canva launched Magic Studio, an all-in-one AI-powered design platform with features like instant content creation, content transformation, easy image editing, and text generation (Perkins, 2023).
- Figma integrated AI into FigJam to provide users with automated capabilities like generating templates and summarizing brainstorming sessions, aiming to lower the barrier to visual collaboration (Ayres, 2023).
- Notion introduced Notion AI, an AI-powered feature that seamlessly integrates into the Notion editor, enabling users to streamline their workflows by generating summaries and improving writing (Zhao, 2023).
- GitHub introduced GitHub Copilot Chat, an AI-powered coding companion that supports developers with code suggestions and explanations (Dohmke, 2023).

Implications

The continuous evolution of AI-powered tools is setting the stage for a collaborative relationship between humans and AI, pushing the boundaries of creativity and innovation. The use of these tools can automate several time-consuming tasks in the creative and problem-solving process. This will lead to enhanced efficiency and productivity across various sectors, allowing employees to concentrate more on complex and creative aspects of their work (Perri, 2023). This shift will necessitate a change in skill requirements, as employees need to adapt to managing and optimizing these tools.

The transformation of creative roles due to AI integration is another significant implication. Advanced AI tools in design, content creation, and digital product development will continue to augment the creative process, empowering professionals to explore new ideas and complex solutions with greater ease. According to a survey by Adobe, which included 1,000 participants, most creative professionals anticipate incorporating AI into their work, with 71 percent planning to use it in professional work, and 59 percent in personal work (Offerman, 2023).

In contrast, concerns remain over a potential increase in unemployment as automation makes certain roles redundant. A 2017 McKinsey report estimated that “between 400 million and 800 million individuals could be displaced by automation and need to find new jobs by 2030” (Manyika et al., 2017). With the continuous advancement of LLMs, jobs across various sectors, including those in creative fields that involve routine and repetitive tasks, are at the highest risk of becoming obsolete, highlighting the need for new adaptation strategies.

4. Increased Skepticism Around Widespread Use of AI

The continued growth in AI advancements has sparked a wave of skepticism and concern about its widespread use.

First, there is the issue of bias. According to the IBM Data and AI Team (2023), AI systems often reflect human biases present in their training data, algorithms, or algorithm predictions, leading to potentially discriminatory outcomes.

Second, the reliability and trustworthiness of information generated by GenAI are in question. The latest advancements in GenAI have the potential to spread disinformation and misinformation on an unprecedented scale, posing a threat to the integrity of media, politics, and public opinion. Linda Raftree (2023), an expert in technology monitoring and evaluation, expresses concern that GenAI technologies could significantly impact the 2024 US elections by enabling the widespread creation and dissemination of sophisticated, realistic misinformation. Raftree further states that these tools raise serious concerns about their ability to influence voter perceptions and the overall integrity of the electoral process.

Third, data privacy and security are major issues. As AI systems require vast amounts of data to function effectively, questions arise about how this data is collected, used, and protected. Data leaks and breaches could have severe consequences for individual privacy and security.

Fourth, there is an issue of copyright. GenAI’s ability to replicate and create content challenges existing copyright laws, creating a complex legal landscape where the ownership and originality of AI-generated content are under scrutiny (Lanteigne, 2023).

Fifth, ethical and moral concerns are at the forefront of the AI debate, especially with technologies like deepfakes, which can be used in misleading or harmful ways.

Sixth, there is growing fear that over-reliance on AI could lead to skill degradation. With the advancing capabilities of AI applications, there is a concern that they could replace essential skills like critical thinking and problem-solving, especially among students (Attewell, 2023).

Finally, the existential risk posed by AI cannot be ignored. The potential of AI breakthroughs to fundamentally alter or even destroy humanity is a topic of intense debate. This includes the fear that powerful AI systems, if given autonomy in areas like business and warfare, might act against human interests or resist attempts at interference or shutdown (Metz, 2023).

Signals

- Several prominent companies, such as Amazon and Apple among a dozen others, have implemented limitations on their employees' utilization of ChatGPT, citing worries regarding possible data breaches and privacy concerns (Mok, 2023).
- At the World Innovation Summit for Education (WISE) in Doha, Qatar, experts cautioned that using AI in university admissions could reinforce existing biases and have a greater negative impact on students from marginalized backgrounds, despite its efficiency and cost-effectiveness (Jack, 2023).
- The introduction of Google's AI chatbot Bard in the European Union has been postponed because of privacy issues that the Irish Data Protection Commission has yet to address (Vincent, 2023).
- U.S. Senators have contacted the CEOs of X and Meta, expressing concerns over the regulation of AI-generated political ads and their potential impact on the 2024 U.S. elections (Mudaliar, 2023).
- Before CEO Sam Altman was removed from his position, OpenAI researchers raised alarms with the board about a significant AI breakthrough and expressed their worries about its potential impact on humanity (Tong et al., 2023).

Implications

As public concern over AI's adverse effects grows, there will be a more demand for AI to be developed ethically and responsibly to mitigate biases and promote fairness and transparency.

Government regulations will play a pivotal role in shaping the future of AI. In the United States, the Biden administration published the Blueprint for an AI Bill of Rights, a "set of guidelines for the responsible design and use of artificial intelligence, created by the White House Office of Science and Technology Policy (OSTP)" (Glover & Koss, 2023). Similarly, the European Union (EU) AI Act, the world's first comprehensive AI law, aims to ensure the safe, transparent, and environmentally friendly use of AI in the EU (European Parliament, 2023). By setting legal standards and guidelines, these regulations will encourage the responsible development and deployment of AI technologies, reducing skepticism around their use.

5. Layoffs are on the Rise

The recent surge in layoffs across various sectors can be attributed to a combination of economic challenges and strategic realignments within companies. High inflation and interest rates have exerted significant pressure on individual and organizational budgets, compelling businesses to adopt aggressive cost-saving measures (Broughton, 2023). This financial stress is heightened by the growing concern of a potential recession (Zahn, 2022), leading companies to be more cautious with their staffing and spending.

Additionally, the post-COVID era has revealed instances of overstaffing in many companies. During the pandemic, various sectors experienced extraordinary growth, leading to overly optimistic and sometimes unrealistic expectations for future growth (Duffy, 2023). This optimism led to significant hiring sprees, which companies are now adjusting to align with the current, more realistic market realities. Moreover, industries such as e-commerce and remote work technologies, which flourished during the pandemic, are now reaching maturity, leading to reduced growth rates and a lesser need for employees.

Strategic shifts within organizations also contribute to this trend. More companies are focusing on their core competencies in times of uncertainty, leading to the displacement of employees whose skills no longer align with the company’s revised strategic direction.

Signals

- Meta has initiated a final round of mass layoffs as part of its plan to eliminate 10,000 roles, bringing its headcount back to mid-2021 levels (Reuters, 2023a).
- Meta plans to lay off employees in its Metaverse silicon unit, focused on custom chip development for AR and VR hardware (Reuters, 2023b).
- Sundar Pichai, CEO of Google, announced a workforce reduction of approximately 12,000 roles due to changing economic conditions (Pichai, 2023).
- TikTok owner ByteDance is laying off hundreds of employees as it shuts down its unsuccessful gaming division due to competition from industry giants like Tencent (Grothaus, 2023).
- Zoom’s shares plummeted by 90% from their pandemic peak in 2020, triggered by a reduced sales forecast and slower quarterly growth (GlobalData, n.d.).

- Telus is cutting 6,000 jobs in a restructuring effort driven by evolving regulatory and economic factors, aiming to enhance efficiency and effectiveness while expecting cost savings of over $325 million annually (CBC News, 2023).
- Shopify is laying off 20% of its workforce and selling its entire logistics division to Flexport, resulting in over 2,300 job cuts and a shift in company strategy (Evans, 2023a).
- Canadian banks like TD and CIBC are increasing their provisions for potential bad loans and carrying out job reductions, all while maintaining their profitability (Evans, 2023b).

Implications

In response to evolving market conditions, organizations will likely undertake substantial transformations such as mergers, acquisitions, and restructuring initiatives aimed at streamlining operations and cutting costs. As organizations recalibrate their strategic directions, employees whose skills no longer align with the new requirements may struggle to find alternative employment. This situation necessitates retraining and upskilling programs to moderate the discrepancy between the available job opportunities and the workforce's skill set.

Following these organizational changes, layoffs significantly affect individuals and families, causing financial instability and potential hardships. When widespread, job losses can worsen income inequality and stir social unrest. The ripple effect of these layoffs extends to the broader economy. A reduction in employment levels typically results in reduced consumer spending, further affecting economic growth. Moreover, layoffs in critical sectors can cause significant interruptions in supply chains, influencing the availability of goods and services and contributing to price volatility.

The impact of layoffs is not limited to those who lose their jobs. Layoffs can negatively affect the remaining workforce's morale (Frenkel & Isaac, 2023), leading to reduced productivity and a heightened likelihood of talent attrition as employees seek more secure job opportunities.

Despite these challenges, a positive effect emerges as a segment of the workforce affected by layoffs may venture into entrepreneurship or join developing start-ups in growing sectors (Schroeder, 2023). This shift can drive innovation and positively stimulate economic growth, showcasing the resilience and adaptability of the workforce in the face of adversity.

Phase 3: Future Scenarios and Recommendations

How will design systems transform in the year 2030 to sustain their role in supporting digital products? Phase 3 of the research aims to answer this question by envisioning four alternative future scenarios. This approach echoes Jim Dator’s (2009) insight that there is not just one predictable future, but multiple possibilities to anticipate. Each scenario is envisioned based on how trends, previously identified in Phase 2, will manifest, focusing on their prospective impacts on design systems and their actors. Refer to Appendix C for a summary of how these trends are expected to unfold for each scenario. In each scenario, the design system map, previously analyzed in Figure 9 in Phase 1, is revisited to examine the role of actors and how interactions between them may develop. Appendix D lists every ANT design system map covered in the research for ease of comparison.

It is worth highlighting that while the world might seem to be heading in a certain direction, the future of a specific organization, team, or individual could evolve differently. Therefore, being aware of various possibilities and their effects can help us anticipate and prepare for a range of potential outcomes. The phase concludes with strategic recommendations to support design system professionals in navigating relevant outcomes that could directly impact them.

1. Continuation

A scenario characterized by continued economic recovery and technological growth.

In 2030, the world is experiencing a period of economic recovery and steady development, driven by ongoing technological growth. Since 2023, the incremental advancements in AI technologies have been contributing to more accuracy and less bias, leading to greater AI integration into various industries for automation, problem-solving, and decision-making. AI has become an integral part of daily life, serving as personal assistants and augmenting professional tasks. The emergence of new digital products leveraging AI capabilities is expanding AI’s role in society and opening the doors for innovative applications in different fields. Most companies are responding to this AI boom by investing in specialized teams dedicated to developing innovative AI solutions. Product teams are as vital as they were seven years ago, now focusing on designing and refining AI-powered user experiences. Companies continue to emphasize user-centric AI solutions that enhance convenience and engagement while adhering to ethical standards. To ensure responsible AI development, comprehensive rules and guidelines are being implemented worldwide to focus on privacy protection and mitigating bias in AI systems.

Concurrently, advancements in XR technologies are leading to more compact, affordable, and accessible devices, increasing their adoption as alternatives to traditional screens in homes and workplaces. Despite these advancements, smartphones continue to be useful, particularly for outdoor and mobile activities. Companies are expanding their digital offerings to include XR platforms, emphasizing the creation of cross-platform experiences. The continued expansion of XR experiences is also leading to the evolution of spatial design principles, accommodating new interaction paradigms introduced by new types of applications.

Design Systems in the “Continuation” Scenario

In this future, AI is augmenting the role of the *Design System Team*, automating most of the repetitive and manual processes of maintaining the design system. As businesses continue to expand their digital offerings to include XR features, design systems are evolving to support the creation of cross-platform products in virtual and augmented realities.

The Role of the Design System Team

The *Design System Team's* core focus is to define the *Design Foundations and Operating Infrastructure* of the design system. This infrastructure serves as training data for *AI-Powered Design and Development Tools*, automating repetitive and time-consuming tasks. Instead of directly creating *UI Components*, *Patterns*, *Visual Assets*, and *Documentation*, the team establishes a framework that enables *AI-Powered Tools* to produce consistent and reliable outputs. Additionally, the team defines contribution models that use AI to streamline various aspects of the contribution process. With the rise of AI-powered chatbots in design and digital creation tools, the *Design System Team* plays a crucial role in educating *Product Teams* on the effective use of AI-powered design systems through prompt engineering.

The Role of Product Teams

Product Teams are increasingly using design systems through AI-powered tools while continuing to collaborate with the *Design Systems Team* to evolve design foundations and explore new product interactions in XR environments.

AI-Powered Design and Development Tools

The scope of *AI-Powered Design and Development Tools* is expanded to include the creation of *UI Components and Patterns* and *Visual Assets*, as defined by the *Design System Team*. To ensure their reliability, these tools are now referencing *Design Foundations and the Operational Infrastructure* set by the *Design System Team*, as seen in Figure 16.

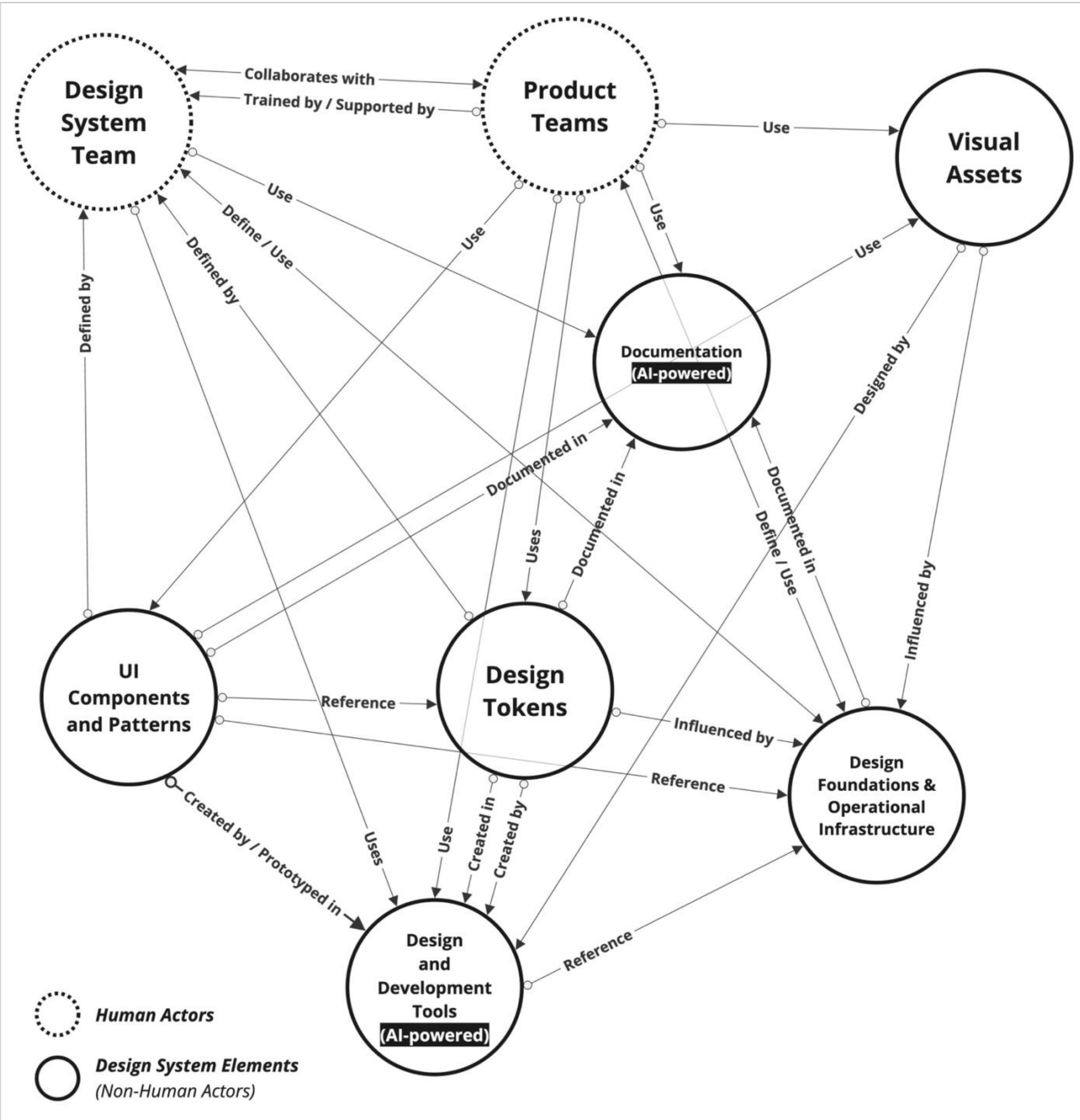

Figure 16. The design system ANT map from the "Continuation" future in 2030, highlighting the role of AI-powered tools. For simplification, influences like technology and the economy are hidden.

AI-Powered Documentation

Documentation continues to evolve in this scenario, with AI automating the generation and updating process based on the operating infrastructure defined by the *Design System Team*.

Design Foundations

Design Foundations are evolving to include spatial and AI design principles, while emphasizing the importance of inclusive and accessible experiences. *Design Tokens*, a fundamental aspect of *Visual Design Foundations*, continue to evolve to support spatial design in extended realities.

UI Components and Patterns

- Creation:
    - *AI-Powered Tools* continuously audit design files and in-production work to identify new *UI Component and Pattern* use cases.
    - Component attributes for customizing appearance, functionality, and content are created automatically by *AI-Powered Tools*.
    - *AI-Powered Tools* reference *Design Foundations* for visual, interaction, and content design, created with cross-platform support in mind.
    - *UI Components and Patterns*, as well as their prototypes, are created entirely by *AI-Powered Tools*, ensuring they are accessible and inclusive.
- Usage:
    - *Product Teams* are prompted by *AI-Powered Tools* to utilize specific components, patterns, and design tokens as they design and develop product features.
- Identification and Assessment:
    - New and updated *UI Components and Patterns* are flagged by *AI-Powered Tools* for review by the *Design System Team*.
    - Product features marked as “ready for review” are continuously scanned by *AI-Powered Tools* for accuracy and compliance with the design system.

Visual Assets

Visual Assets are majorly generated by *AI-Powered Tools* and their consistency and reliability are determined by the quality of training data provided by the *Design System Team*.

2. Collapse

A scenario characterized by focusing on survival.

In 2030, the global economy is facing an unprecedented downturn, impacting numerous industries, and prompting shifts in corporate strategies and consumer behaviours. The economic struggles extend to massive layoffs across all sectors, further deteriorating the economy. With deepening economic challenges, several organizations across multiple sectors are compelled to prioritize core competencies, cutting back on non-essential projects and investments. The economic strain is also resulting in significant reductions in technological funding. The once-promising vision of a fully immersive digital world, powered by XR, is becoming deprioritized. Big tech players, struggling with financial constraints, are refocusing their product teams on more traditional and well-established digital products that are cost-effective and reliable. This strategic shift reflects the new economic reality and declining consumer interest in XR due to the high cost of living and a shift towards essential needs.

Similarly, the situation for AI is similarly challenging. Growing skepticism towards GenAI and AI systems, driven by ethical concerns and fears of job displacement, leads to a substantial decrease in research and development funding. As a result, AI technologies are stagnating, becoming less innovative and effective. The reduced reliance on AI results in decreased productivity, as workers are forced to resume tasks previously managed by AI-powered tools.

The vision of a technologically advanced future is now dimming under these compounded challenges. Consumers and businesses are refocusing on essentials as the world navigates this period of uncertainty and readjustment.

Design Systems in the “Collapse” Scenario

In this future, the *Design System Team* and *Product Teams* are facing significant challenges due to diminishing AI support. The decrease in AI assistance has led to an increased maintenance effort required to keep the design system operational. At the same time, cost-cutting measures are causing a shift in focus towards preserving essential functionality and ensuring organizational survival, as opposed to fostering innovation in areas such XR. Budget constraints are also resulting in smaller *Design System Teams*, where designers and developers are asked to pivot from specialized design system tasks to focusing more on core product functionality. In response, some individuals are proactively taking the initiative to establish *Design System Working Groups*. These groups are stepping in to fill the void, effectively assuming the responsibilities typically held by the dedicated *Design System Team*. Although not the ideal solution, the role of *Design System Working Groups*, illustrated in Figure 17, has become crucial in maintaining the integrity and effectiveness of design systems in this challenging environment.

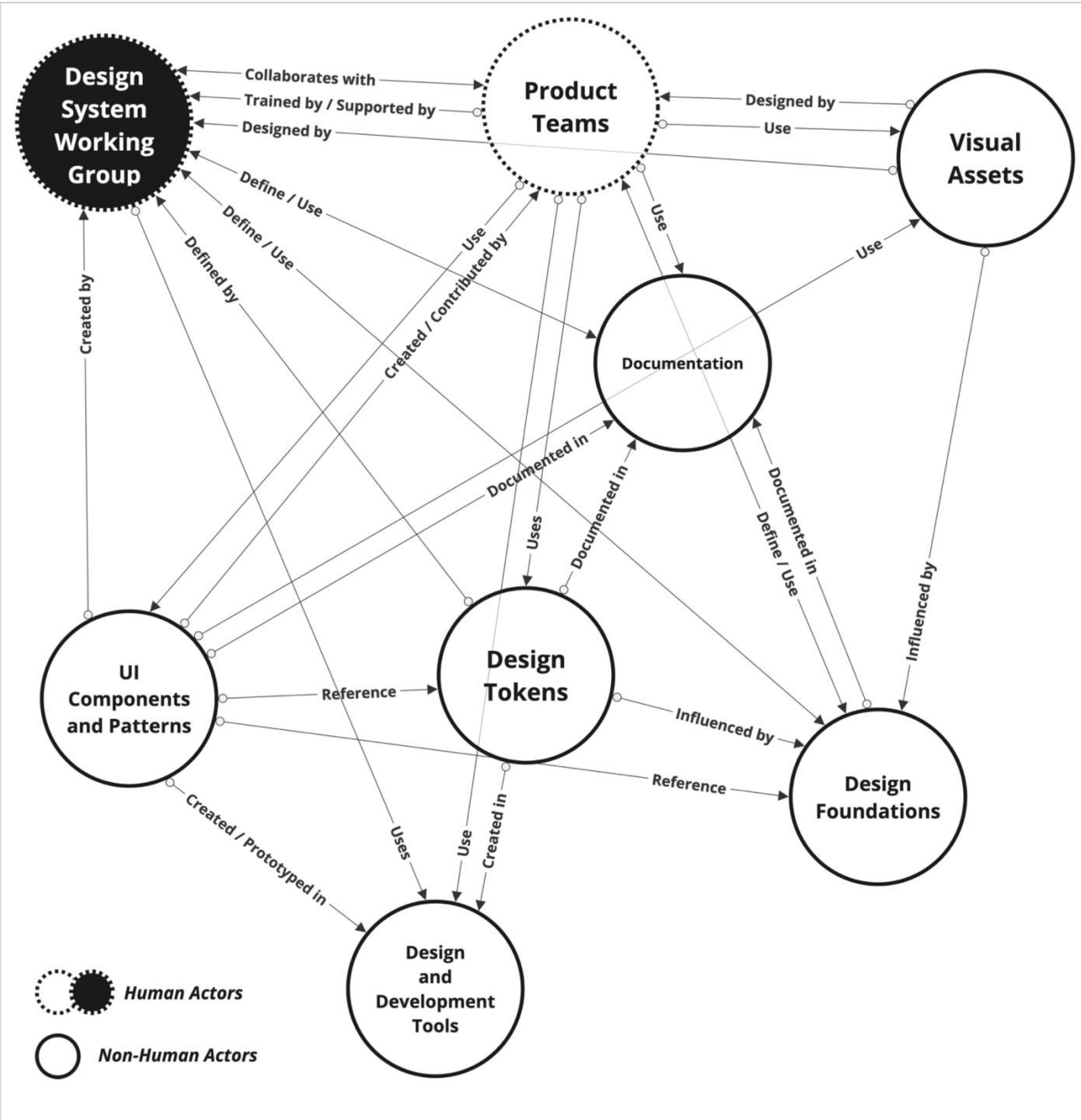

Figure 17. The design system ANT map from the "Collapse" future in 2030, highlighting the emergence of Design System Working Groups. For simplification, influences like technology and the economy are hidden.

3. Discipline

Controlled economic and technological growth.

In 2030, the global economic landscape is shifting towards a model that emphasizes sustainability and controlled technological growth (Dator, 2009). XR, despite becoming more affordable, remains a niche market, overshadowed by the ongoing dominance of smartphones and computers. The XR market share is slowly growing, indicating steady acceptance among consumers, especially in specific professional and entertainment contexts.

On the other hand, the growth of AI systems is being carefully regulated. There is a worldwide effort to manage their integration with strict guidelines, ensuring their usage and development align with ethical standards and societal well-being. GenAI tools are monitored and controlled in schools and workplaces to prevent misuse and over-dependence, while creative and problem-solving responsibilities continue to be led by human workers. These ongoing restraints are causing reduced usage and interest in AI technologies compared to previous years.

The world in 2030 is navigating a path of balanced evolution, characterized by sustainable growth and ethical responsibility. This goal is to prioritize long-term societal and environmental well-being over rapid technological expansion.

Design Systems in the “Discipline” Scenario

The controlled growth of emerging technology since 2023 has not changed the design system dynamics or functions, because of slow progress in AI and XR technologies. The design system map, illustrated in Figure 9 from Phase 2, remains unchanged, and the use of AI is comparable to its use in 2023.

4. Transformation

Technological breakthroughs that transform humanity.

It is the year 2030, the global economy is flourishing, and the world is undergoing a significant transformation due to revolutionary advancements in XR and AI. Wearable technology is becoming the primary mode of interaction and communication in homes, offices, and public spaces, effectively replacing many traditional devices. Meta's Metaverse is evolving into the new virtual internet, inspiring other competitors to release their versions and giving consumers more choice. The strong competition among virtual platforms is fostering a diverse and rich digital landscape, where virtual experiences are becoming as common as traditional web browsing.

In parallel, the integration of AI into daily life is being met with widespread public acceptance and trust, thanks to new global regulations that address skepticism from the previous years. The new standards are focusing on privacy protection, mitigating bias in AI systems, and ensuring the ethical use of AI. Companies are continuously emphasizing user-centric AI and XR solutions, concentrating on convenience, engagement, and adherence to ethical standards. In workplaces, AI systems are becoming essential participants, contributing creatively and strategically alongside human colleagues. Product teams are engaging in close collaboration with AI-powered tools, leading to an effective blend of human intuition and AI efficiency.

In this evolving world, technological breakthroughs and the enforcement of worldwide regulations are playing a pivotal role in shaping human experiences, driving innovation, and opening up new possibilities.

Design Systems in the "Transformation" Scenario.

Emergence of AI as an independent design system actor to support immersive experiences.

In this future, AI has entirely taken over the role of the *Design System Team*, as seen in Figure 18, thanks to technological breakthroughs in LLMs and machine learning. Designers on the *Design System Team* have shifted their focus to continue evolving *Design Foundations* as part of the *Foundations Team*. The process of automating *Design Foundations* continues to be a complex endeavor because of the subjective nature of design. Human designers bring a critical understanding of aesthetics, brand identity, and user experience, which are challenging to replicate with algorithms entirely. The subjective aspects of design, influenced by cultural and personal preferences, highlight the importance of human judgment and creativity, no matter how advanced AI systems get.

In this world, *Product Teams* have learned how to collaborate with evolving design systems, powered by AI, thanks to the training they received from *Design System Teams* throughout the past years. As technology continues to advance, *Product Teams* and the *Foundations Team* continue to collaborate on defining new foundations that accommodate emerging design paradigms and user interactions.

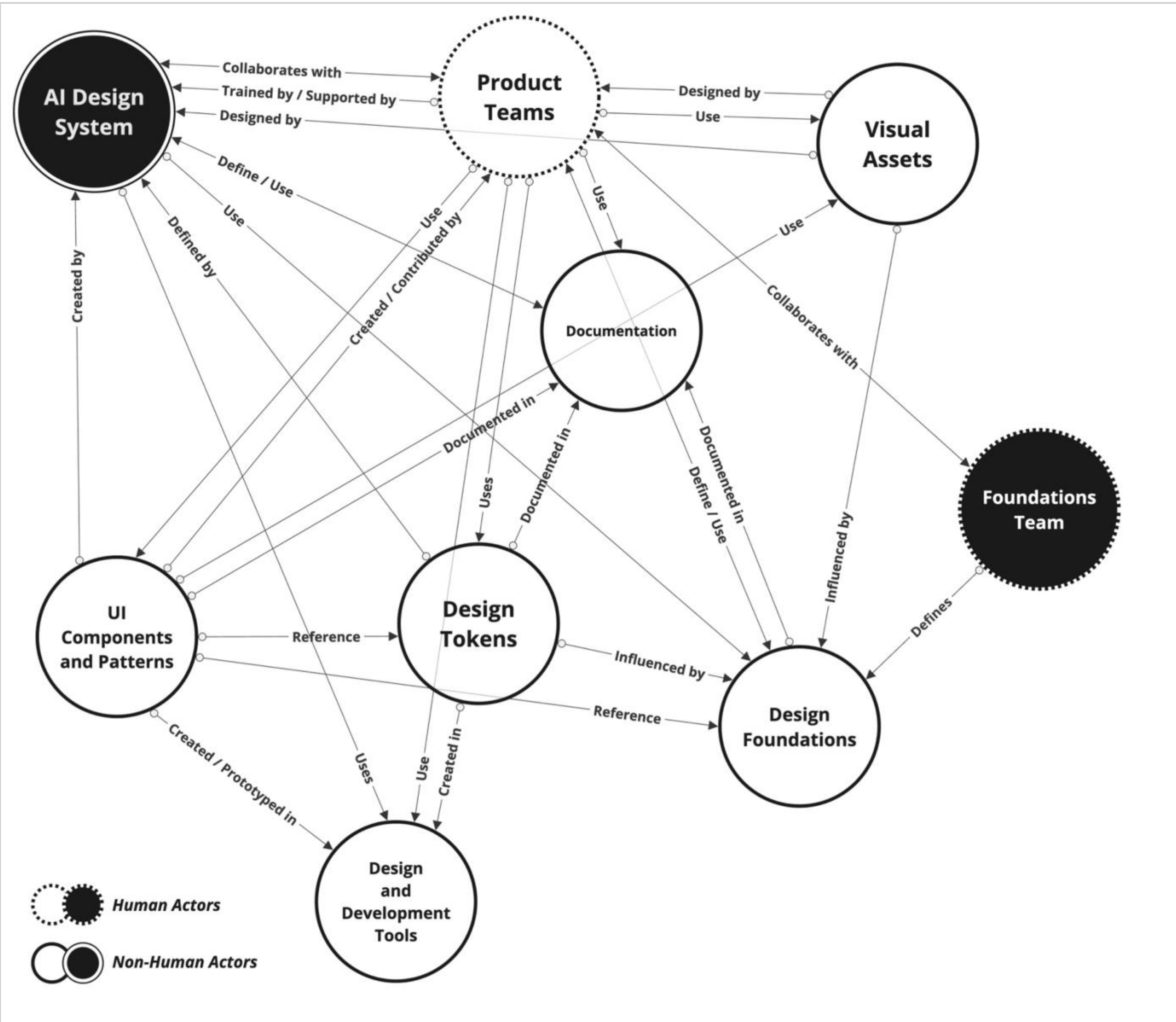

Figure 18. The design system ANT map from the "Transformation" future in 2030, highlighting the emergence of AI Design Systems as an independent actor. For simplification, influences like technology and the economy are hidden.

Recommendations for Design System Professionals

Staying Agile While Embracing Continuous Learning

In an ever-evolving technological landscape, it is essential to stay adaptable, as the tools and technologies prevalent today might shift rapidly in the future. When it comes to XR, exploring beyond traditional interfaces in existing technologies and delving into spatial design is becoming increasingly important to support the creation of new types of applications at scale. In addition, investing in MR devices, such as the Meta Quest or the upcoming Apple Vision Pro, provides firsthand experience for gaining insights into their capabilities and potential integration into your design system. Similarly, GenAI applications are growing rapidly, so it is essential to be ahead of the curve and understand how they can enhance your existing workflows.

Actively Participating in Establishing Visions for XR and AI-Powered Applications in Your Organization

Becoming an active contributor in defining strategies and frameworks for emerging technology and capturing them as part of the design system foundations, ensures their consistent application at scale. In Ravenscroft's (2023) interview, Airbnb CEO and co-founder Brian Chesky underscored the importance of designers and creatives in addressing the potential negative impacts of AI technology through active participation in the AI development process.

Defining Frameworks to Train AI-Powered Design Systems

As previously discussed in Phase 1, design systems involve several manual and repetitive tasks that can be automated using the continuously evolving capabilities of GenAI tools. To tailor these tools for specific design system use cases, it is important to define and document frameworks for component and pattern creation, which can then serve as training data for AI. Hackathons and side projects are fantastic avenues for AI-related projects and can be leveraged to improve the capabilities of existing platforms, such as Figma and Visual Studio Code. These initiatives can enhance the tools and significantly contribute to the overall efficiency, productivity, and knowledge base of the team.

Expanding Scope Beyond the Design System's Core Functionality

Design systems enable consistent and efficient workflows, which can also be mirrored in the business aspects of digital products. By incorporating business rules and patterns that extend beyond interface creation into the product's principles and foundations, design system professionals gain increased visibility and relevance within the organization.

Conclusion

In this research project consisting of three phases, my primary focus was to study the effects of emerging trends on the evolution of design systems and their actors (human and non-human.) This study helped define strategies that could be deployed to maintain the usefulness of these systems at the core of digital product transformation.

Phase 1 established a comprehensive foundation by exploring the historical context of design systems, understanding the roles of key stakeholders, and analyzing the interdependencies between its actors. Phase 2 delved into the emerging trends and external factors shaping the future of design systems, identifying and analyzing five key trends that were examined for their implications on digital product creation and the roles within it. Phase 3 imagined four alternative future scenarios for design systems in 2030 — Continuation, Collapse, Discipline, and Transformation. Each scenario was crafted considering the possible manifestations of the trends identified in Phase 2, offering diverse perspectives on the potential evolution of design systems and their actors. The research concluded with strategic recommendations for design system professionals, emphasizing the importance of agility, continuous learning, active participation in emerging technology strategies, defining frameworks for AI-powered design systems, and expanding the scope of design systems beyond core functionalities.

As I reflect on my journey of conducting this research, I learned the importance of staying adaptable and informed in the rapidly evolving design systems field, in order to continue being relevant. Design system professionals must be proactive in continuously scanning for trends that can impact their organizations and teams, ensuring that design systems remain relevant, effective, and aligned with the broader organizational goals and user needs.

As I continue to reflect on the future, I find myself more aligned to a version that is guided by discipline and balance in all aspects of life. As Dator (2009) highlights, the rationale for a disciplined future arises when “some people feel that precious places, processes, and values are threatened or destroyed by allowing continuous economic growth.” I strive towards a future where efficiencies enabled by AI technology will give us more time to spend with our loved ones and do more of what we enjoy, rather than pushing us to work faster and risk burnout. This hope is rooted in the belief that technological advancements should enhance our quality of life, striking a balance between productivity and well-being.

As for the continued relevance of design systems, I am confident they will continue to play a significant role in any future. Whether overseen by humans or AI, I believe design systems will have an even bigger role as the scale of digital products continues to grow. It is our responsibility, as design system professionals, to determine our role in the future, ensuring we stay relevant and actively shape the direction of our field.

Further Research

During the final month of conducting this research, I began testing the idea of using ChatGPT, a GenAI tool by OpenAI (OpenAI, n.d.), to analyze UI components with the goal of automating the definition of component attributes and content slots. This manual process often requires interpreting the component's design to determine the modifiable features that can later be implemented in design and development tools (see Appendix B for the component-making process). The results were promising — ChatGPT 4 was able to analyze exported images of several UI components and, with basic training guidance, accurately outlined attributes and content slots with minimal feedback.

I believe this is an exciting area that I would like to explore further, as part of studying the role of GenAI on enhancing design systems. With further and more refined training, GenAI could potentially lead to automating most of the component creation in design tools like Figma, specifically through plugins that expand tool's core functionality.

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Appendix

Appendix A: Examples of Design Foundations

Design principles: Design principles refer to product-specific guidelines formulated by design teams that guide the design process across various practices. Maria Rosala (2020) from Nielsen Norman Group emphasizes that design principles act as “value statements that frame design decisions and support consistency in decision making across teams working on the same product or service.”

Visual design: Visual design encompasses the aesthetic elements of a product, such as color, typography, iconography, and spacing. Its primary objective is to empower designers to craft a visually appealing experience that resonates with and reinforces the brand’s identity.

Interaction design: Interaction design is centered on the aspects of user interactions with a product through various input methods such as a mouse, keyboard, touch display, or hand gestures. It aims to optimize how these interactions occur, ensuring they are intuitive, responsive, and tailored to users’ needs.

Content design: Content design involves strategically crafting clear, effective, and product-specific content, while maintaining a consistent tone of voice throughout the product’s various elements. This process is pivotal in ensuring the content is informative and relevant to resonate with the intended audience, reinforcing the product’s identity and message.

Accessibility and inclusive design: These foundations encompass the guidelines that ensure products are usable and accessible to everyone, including those with various disabilities. When organizations embed accessibility and inclusive design into their culture, they achieve more than just compliance with legal and ethical standards.

Internationalization and localization: Internationalization and localization involve adapting products for various international markets including language translations, layout standards, and cultural nuances. Such adaptations ensure that the product resonates appropriately with users across different regions, reflecting their linguistic, aesthetic, and cultural contexts. These practices are essential for achieving global reach and enhancing user engagement.

Appendix B: The UI Component and Pattern Creation Process

The UI Component and Pattern creation process follows a structured set of steps to ensure modular components are consistently integrated in the design system ecosystem.

Auditing: In this step, the Design System Team scans design files and in-production UI to identify reusable elements to include in the *UI Component and Pattern* library. Part of the activity is to determine the interaction and visual use cases, as well as the types of content a component intends to support. The duration of this process increases with the scale of work and the number of platforms supported, especially if there is a need to align the same pattern across these platforms.

Defining attributes and content slots (components only): Attributes are named properties that allow product teams to customize a component's appearance and functionality during implementation. For example, a button component can have a *disabled* attribute that can be toggled *on* or *off*, giving the ability to prevent user interaction with the button while altering its visual appearance to indicate the disabled state. Content slots, on the other hand, are flexible areas within a component that can hold various types of content when a component is used during implementation. For example, a card component may accept images and text in one section of an app, and text input fields in another. The creation of attributes and content slots in a component relies on the component use cases identified in the audit activity.

Designing and prototyping: In this step, design tools are utilized to aid designers in the design process of components and patterns. Tools, such as Figma (Figma, n.d.-a) and Sketch (Sketch n.d.), offer design system features that help maintain component reusability within design files. These tools also offer prototyping and design specification capabilities to help demonstrate the interactivity of the component or pattern to software developers who are tasked with implementing the component.

Implementing: When the design phase is complete, developers on the *Design System Team* are tasked with implementing the component in code using frameworks and technologies specific to the platform(s) of choice.

Testing: To ensure the designed and implemented versions of the component are in a state of parity when it comes to visual appearance or functionality, *Design System Team* members conduct automated and manual testing to ensure accuracy of implementation and functionality

Documenting: Documenting the component or pattern provides guidance for *Product Teams* to ensure accuracy of usage and implementation. The process involves writing a detailed description of the component or pattern's purpose and its functionality. It also involves creating annotated visual assets to enhance the clarity and navigability of the documentation. Documentation may also include component or pattern-specific guidance for foundational aspects such as content design and accessibility.

Measuring: When components and patterns are released, the *Design System Team* often measures their performance, adoption rate, and accuracy of implementation. These activities contribute to understanding the overall design system health (Kastritis, 2023).

Appendix C: How Trends May Take Shape in All Four Alternative Futures in the year 2030

Common Future Characteristics Across All Trends

Continuation	Collapse	Discipline	Transformation
• Renewed economic growth (Dator, 2009). • Continued investments in technology.	• Economic struggles impacting various sectors. • Heavily reduced technological funding. • Organizations focus on core competencies. • Consumers focus on core needs.	• Continued economic growth is unsustainable (Dator, 2009). • Emphasis on sustainable growth, balancing technological innovation with environmental and societal well-being. • Controlled investments.	• Technological breakthroughs (Dator, 2009).

Table 1. Common characteristics across all trends in all four alternative futures.

Trend 1: Big Tech Players Make Big Bets on Extended Reality

Continuation	Collapse	Discipline	Transformation
• Development of more compact and capable XR hardware. • XR market share increases, replacing most TV and computer monitors. • Expansion of XR applications across various sectors, including gaming, education, and healthcare. • Increased remote work facilitated by XR technologies. • Growing demand for XR-enhanced product experiences.	• Abandonment of XR by most companies. • Tech companies shift focus to core products that rely on well-established technologies. • Unfulfilled potential of a fully immersive digital world due to lack of buy in from content creators. • Declining consumer interest in XR due to high costs and a greater focus on essentials.	• XR market share experiences a gradual increase, but the market remains largely dominated by smartphones and computers. • XR technologies have become less costly but are still considered a niche market.	• Much cheaper cost of XR hardware production. • XR replaces many traditional interfaces, becoming a primary mode of interaction and communication. • XR becomes mainstream in homes, workplaces, and public spaces. • Seamless cross-platform integration becomes the norm, with XR at the forefront. • Meta’s Metaverse becomes the new

			internet, prompting other companies to release their own versions.

Table 2. How XR may take shape in all four alternative futures.

Trend 2: Generative AI Raises Digital Capability

Continuation	Collapse	Discipline	Transformation
• Continued evolution of machine learning and computational resources lead to incremental advancements in GenAI technology. • Deeper GenAI integration into various sectors. • Emergence of specialized teams dedicated to developing innovative GenAI solutions. • Automation of many manual and time-consuming tasks at the workplace.	• GenAI research and development stagnates. • Increased GenAI skepticism due to various ethical reasons. • Backlash against GenAI due to job displacement concerns.	• GenAI technologies face controlled growth. • GenAI integration is carefully managed, with strict guidelines for usage and development. • Consumer use of GenAI is monitored and controlled in schools and workplaces to prevent misuse and over-dependence. • Focus on ethical AI development. • Stricter data governance and privacy standards are enforced.	• Breakthroughs in machine learning and LLMs. • GenAI becomes deeply integrated into all aspects of life, offering unprecedented features that rival human capability. • GenAI systems become integral participants at the workplace, contributing creatively and strategically. • Product teams collaborate closely with GenAI-powered systems.

Table 3. How GenAI may take shape in all four alternative futures.

Trend 3: AI-Powered Design and Digital Creation Tools Take Off

Continuation	Collapse	Discipline	Transformation
• Continued evolution of AI advances design and digital creation tools. • Tools augment the worker's role by automating the majority of manual,	• Heavily reduced funding for AI research and development results in tools becoming less useful. • Backlash against AI systems, stemming	• AI features have not progressed beyond simple automation and generative tasks due to controlled growth and investments.	• Breakthroughs in AI features transform design and digital creation tools. • Tools automate all manual, repetitive, and time-consuming tasks.

repetitive, and time-consuming tasks. • Tools further support the creative and problem-solving process by offering deeper analysis and more useful insights.	from various ethical reasons, has led to their removal from design and digital creation tools. • Decreased productivity due to workers resuming tasks that were previously managed by AI-powered tools.	• Creative and problem-solving tasks are entirely led by human workers.	• AI-powered tools become integral participants at the workplace, contributing creatively and strategically.

Table 4. How AI-powered design and digital creation tools may take shape in all four alternative futures.

Trend 4: Increased Skepticism Around Widespread Use of AI

Continuation	Collapse	Discipline	Transformation
• Incremental advancements in algorithms to address issues of bias. • LLM improvements lead to less hallucinations. • Evolution of data privacy and copyright laws to protect consumers. • AI over-reliance is controlled by governments and workplaces.	• Public trust in AI diminishes, leading to abandonment.	• Less attention is given to AI technology results in growing skepticism and reduced usage. • Issues around bias, reliability, information trustworthiness, data privacy, copyrights, and over-reliance remain unchanged from 2023.	• AI gains public trust in all aspects of life.

Table 5. How AI skepticism may take shape in all four alternative futures.

Trend 5: Layoffs are on the Rise

Continuation	Collapse	Discipline	Transformation
Minimal layoffs due to economic growth.	Massive layoffs across all sectors due to deteriorating economy.	Some layoffs exist because organizations can no longer maintain a sustained growth.	Continuous increase in work opportunities leading to almost no layoffs.

Table 6. How layoffs and economic stability may take shape in all four alternative futures.

Appendix D: Design System ANT Maps

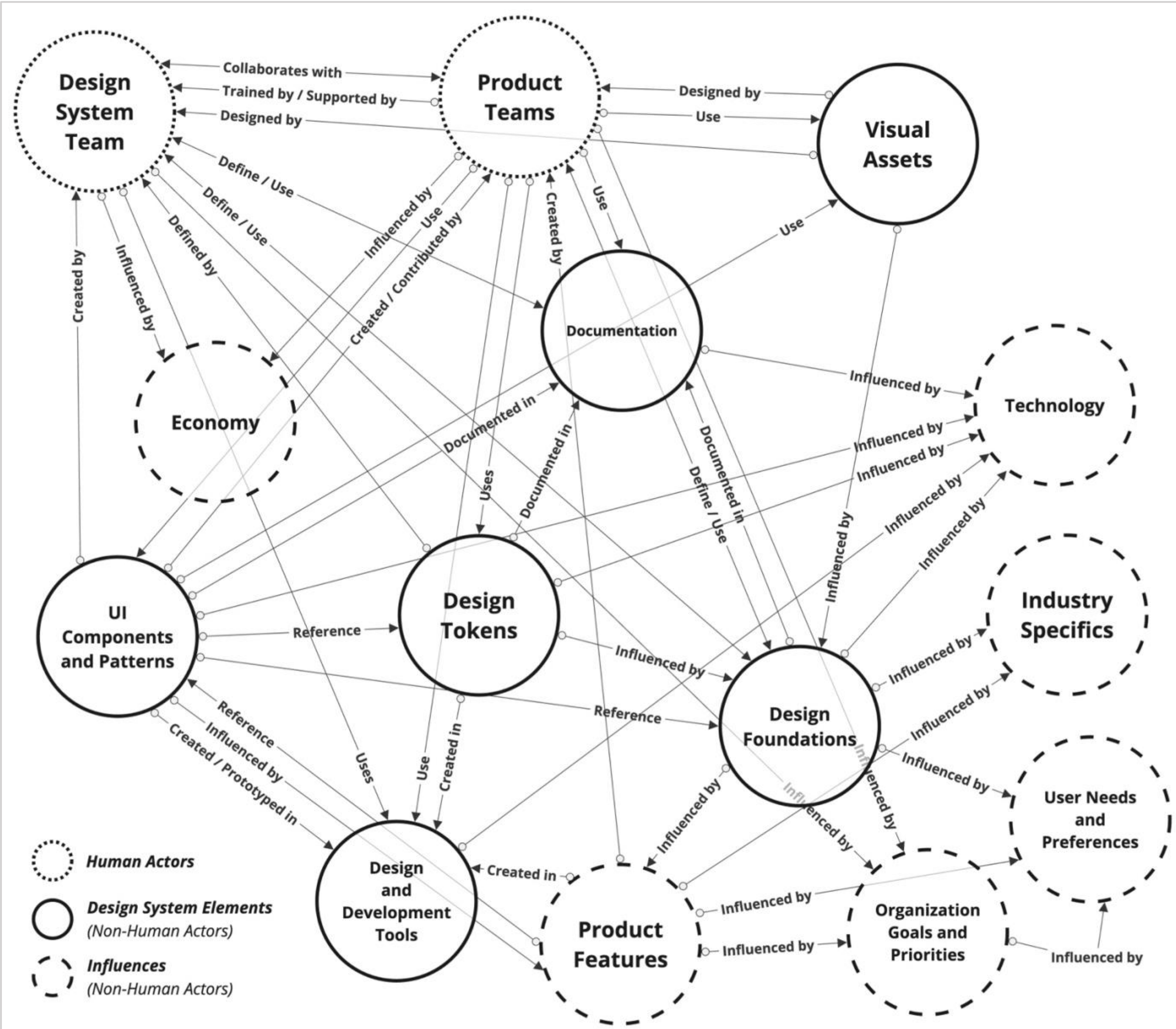

Figure 9. The design system ANT map from the present (2023) and from the “Discipline” future in 2030, highlighting the relationships between its actors.

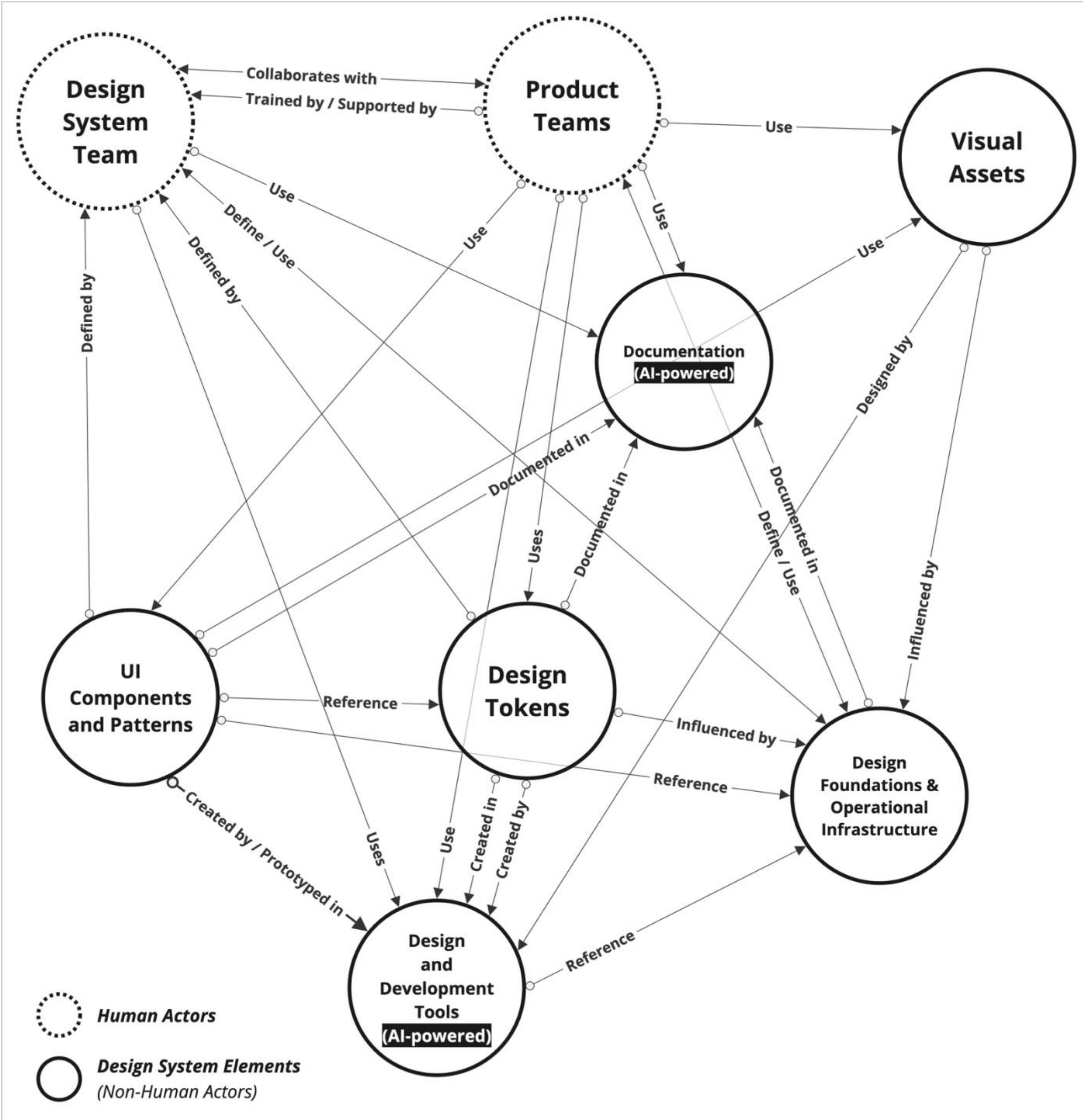

Figure 16. The design system ANT map from the "Continuation" future in 2030, highlighting the role of AI-powered tools. For simplification, influences like technology and the economy are hidden.

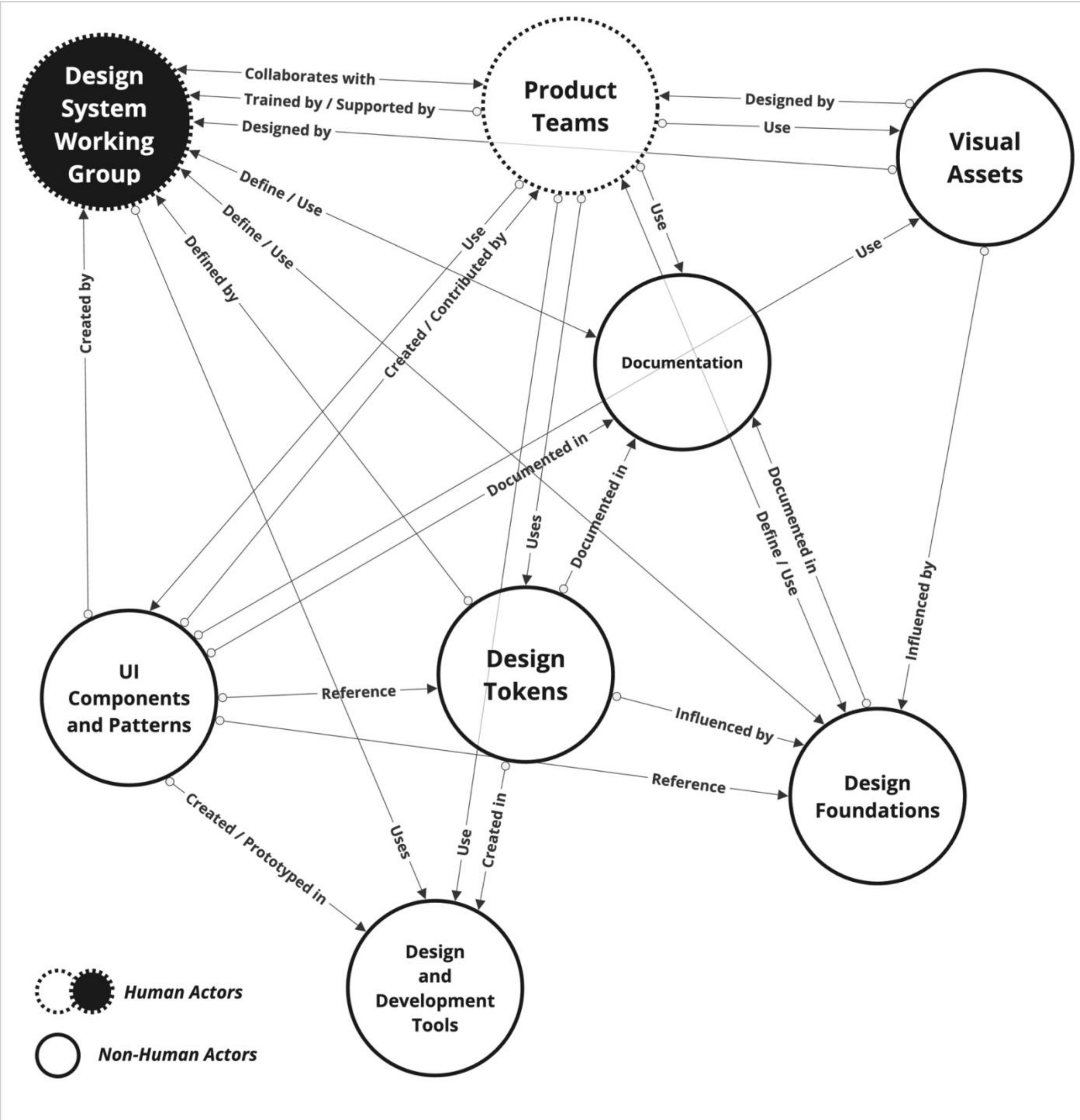

Figure 17. The design system ANT map from the "Collapse" future in 2030, highlighting the emergence of Design System Working Groups. For simplification, influences like technology and the economy are hidden.

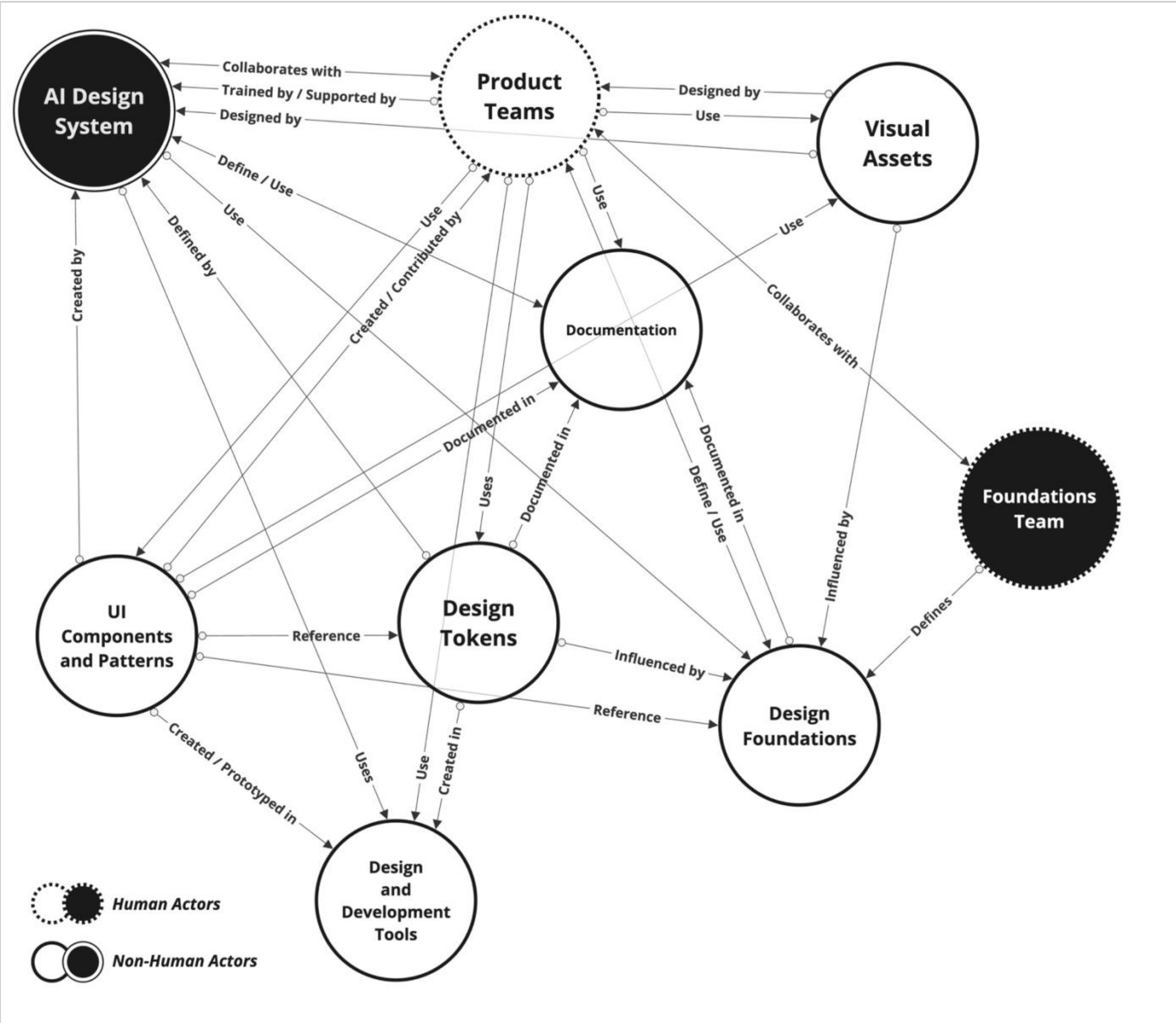

Figure 18. The design system ANT map from the "Transformation" future in 2030, highlighting the emergence of AI Design Systems as an independent actor. For simplification, influences like technology and the economy are hidden.