AN ANALYSIS INTO DESIGN SYSTEMS, THEIR EVOLUTION AND THEIR USE IN GOVERNMENT

Analyzing the state of design systems in Canadian e-Government initiatives

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ABSTRACT

Internet use over the past twenty years has grown at an exponential rate worldwide and by all estimates, shows no signs of stopping. Canada alone, saw nearly 57% of households connected to the Internet in 2003 [1], with that number nearly doubling to 92% in just over two decades, in 2020 [2]. This ever-increasing rate of adoption has pushed many governments to transition their traditionally offline presence, online. This, however, has presented a new set of challenges for these traditionally offline organizations to tackle; how do you have a user friendly, unified, and consistent presence in the digital realm? The answer to this complex question for many governments in 2022 is to follow in the path of industry and take on creating their own design systems to manage and unify their digital presence.

This paper aims to explore what exactly design systems are, their history, what constitutes a "basic design system", as well as exploring the current design system created by the Government of Canada. Additionally, this paper will compare the design system offered by the Government of Canada to that offered by the Government of the United Kingdom and by industry, with the aim of acting as a primer into design systems, analyzing their current state in government (with suggestions of improvements), and exploring the challenges they face to improve them.

CCS CONCEPTS

• Human-centered computing • Human Computer Interaction (HCI) • Interaction Design • Applied computing • Law, social and behavioral sciences • Computing in other domains

KEYWORDS

Design Systems, Interaction Design, Design Languages, Government Design, e-Government, Canada, United Kingdom, public policy

1 WHAT ARE DESIGN SYSTEMS & THEIR ATTRIBUTES?

Prior to being able to cover their use within the public sector, it is important to define what exactly design systems are, and the history they come from. Design systems are a product of the ever-evolving thought/approach to designing cohesive experiences and identities that are applicable to products in a wide range of mediums, although, design systems are most often associated with and used within digital applications, such as web applications [3].

Due to their ever-evolving nature, the rules and literature around design systems is everchanging, as such, there isn't a full agreement to what they should be or what they consist of. In the most abstract and broad sense, design systems are made up of a philosophy, a set of interaction patterns, and a content format [4].

A design system's philosophy establishes the reasoning and vision for the overall system, providing a guiding "ethos" for what the system is set out to achieve [4], it's interaction patterns on the other hand, set out behaviours users interact with, and are most often the greatest visible part of a design system. They are often portrayed as sets of reusable components that can be used in various, established interaction flows, which set to help designers/developers create effective, consistent experiences easily. They additionally aid in enabling ease of use and quick pattern recognition for users [4]. On the other side of things, content format guides in design systems are often the most non-visible part of the system. They are used within a design system to guide the creation of new content (text, media, etc..) in a quick, easy, and consistent way [4].

This initial definition of design systems is quite broad, and such is unfortunately difficult to interpret. A more narrowed, focused definition is that; design systems most often are a group of interaction patterns, guides, advice, and components (or examples) presented cohesively in one place. They most often include but are not limited to offering guidance for visual elements of a design, (such as colour pallets, typography, user-interaction flow, layout,

animation, and shape) and non-visual elements used throughout a design, (such as offering advice on managing tone, personality, and branding in content within the design system). They, additionally, and most crucially, offer pre-built components or examples that implement the guides, principals, and advice to aid in implementation of the design system in an application. Given this, in general, design systems can be described as; "an all-encompassing system which helps to guide and achieve a cohesive and consistent product or set of products" [5].

It is important to note, that while the focus of this paper is on the implementation of design systems on digital products, particularly websites, design systems can work within non-digital, or non-visual domains as well. Examples such as guidance for haptic feedback, vocal feedback in voice recognition systems as well as interaction guidance for physically interactive elements can also be included in design systems as needed for the product to which they're applied [3]. The abstract idea of "design systems" is not limited to one interaction or visual medium but is expandable to whichever human-computer interaction medium they are needed for.

1.1 THE EVOLUTION OF DESIGN SYSTEMS

"Design systems" as they are known now have a long, complex and historied past, the foundation of which is not rooted in the field of human computer interaction, but rather print & logo design. The modern graphic design movement, particularly, the Bauhaus movement of 1913-33 and the Swiss Style (also known as the International Typographic Style) trend of the 1950s and 60s is likely the birthplace of the principals of what is now consider design systems. [5]. These movements focused on the central theme of clean typographic styles, employed simplicity, often emphasized the use of grids, and enforced strict proportioning principles, alongside heavy relying on colour theory to effectively communicate the content to which they were applied. These movements are argued to have heavily influenced modern web design as well as influenced the principals-based approach the that all design systems play off [5].

While these graphic design movements have parallels with, and have heavily influence the principals of what constitutes design systems, the full picture doesn't truly come into view for the computing field until around until later in the 2010s, when the idea of taking a "system's level" approach to design (both visual and interaction) started to take off within the software development industry [6]. This change in thinking, compounded by companies moving to an agile approach to development, necessitated faster, and quicker ways to iterate on products with minimal friction [5]. This necessity led to designers and developers using customized CSS frameworks such as Twitter Bootstrap to create their web applications due to their component-based model. However, the rigid, and similar look these frameworks provided led web designers to move away from them onto custom components based off basic style guides. These style guides eventually evolved to design languages, and then full-fledged design systems (encompassing components, guidance, etc..) as they are known today [6].

2 DESIGN SYSTEMS IN GOVERNMENT

In 1996, the *Treasury Board of Canada Secretariat* mandated the *Government Telecommunications and Informatics Services Branch* (GITS) create the "Government of Canada's Primary Internet Site" [7] in response to the rising number of Canadians on the then infantile web. This mandate marked the beginning of the Government of Canada's foray into "e-Government" (the use of the Internet, by governments, to interact with citizens [8]). This set the stage for the Government of Canada digitizing its traditionally offline presence.

Figure 1: A screenshot of the 1996 landing page of canada.gc.ca, the Government of Canada's official homepage.

As the decades wore on, and web browsers progressed, the idea of e-government, much like the rest of the web, evolved from publishing basic webpages with information, to building web applications, which could provide citizens a way to access government services [8]. This required bringing online an ever-increasing number of government ministries to the web, a consequence of which, meant that an effort had to be made to provide some standardization between the various web presences.

Standardization of the Government of Canada's web presence followed the same evolution/path to what lead to the use of design systems on the wider web today (as covered in Section 1.1). Originally, these early standardization efforts centered around basic things such the required use of the *.gc.ca* domain for all government websites [9] (while each website still maintained its own bespoke design, with some shared elements). This eventually transitioned near the 2010s to the use of a standardized CSS framework developed by the government, entitled the "Web Experience Toolkit" (WET) (similar to Twitter's Bootstrap) to accommodate increased need for all Government of Canada websites to behave in similar ways for mobile devices [10]. Finally, in 2019, with the realization that the Government of Canada needed to revitalize their web presence and build a recognizable, consistent experience across their many services (akin to the governments existing offline standardization program, the Federal Identity Program). The Digital Transformation Office acknowledged that a "one-size-fits-all" strategy would not be suitable, and as such, a revamped Canada.ca Design System was launched, aiming to provide design guidance, components, and guidelines applicable to a wide variety of digital mediums. [11].

2.1 EXPLORING, ANALYZING AND COMPARING CANADA'S DESIGN SYSTEM

2.1.1. Exploration & Analysis criteria. What does the Canada.ca Design System include, and does it meet the minimum criteria to be considered a design system? Using academic characteristics of a design system laid out in Section 1, a basic design system, should, at a broad level, include the following:

- A guiding ethos/vision/philosophy
- Interaction patterns
- A content format guide

Using a more narrowed definition, a standard design system should, in general be presented as a group of interaction patterns, guides, advice, and components (or examples). These guides should be presented cohesively in a singular place and should include but are not limited to, guidance for visual elements of a design, as well as non-visual elements used throughout a design (such as offering advice on managing tone, personality, and branding in content). This advice should be detailed and allow developers and designers to implement the design system in a wide variety of applications. Given these set of requirements, the rest of this section will aim to explore & scrutinize Canada.ca Design System with this list in mind.

Figure 2: A screenshot of the Canada.ca Design System documentation located at design.canada.ca.

Observing the guidance from a broad level overview, the Canada.ca Design System (located at design.canada.ca), is very straightforward and to the point. It provides the reader with quick access to several subsections of the design system, including links to several of the macro-level required items. These items include, interaction patterns, a content style guide, and while not easy to find, a guiding philosophy [12] backing the system. As such, from a broad overview, the design system passes the initial, broad criteria listed above.

Delving in deeper into the design system and exploring it's included guidance, it's clear that the system is quite well rounded and developed. The Canada.ca Design System includes 41 combined components and design patterns, each with their own sample code (if applicable), usage guidance, warnings against incorrect use and various user experience pitfalls, as well as instructions on how to best implement each given pattern or component. [13]

Figure 3: A screenshot of the Canada.ca Design System guidance on buttons.

Beyond visual components, it also provides guidance for non-visual items, including an extremely detailed content style guide for managing tone, personality as well as accessibility when producing text for display using the design system. It also contains guides for other non-visual elements, such as the correct usage, and implementation of the canada.ca/gc.ca domain. [14]

Judging the design system via our "focused" criteria, it's clear that the Canada.ca Design System meets those marks, its documentation is presented in a cohesive place, contains guidance for both visual and non-visual design patterns, and contains useful guidance for adapting and implementing the design system in a multitude of contexts, as such, it fully meets the basic requirements to constitute a design system.

2.1.2. Canada.ca Design System compared to other government initiatives (GOV.UK). When explaining their rational for creating the Canada.ca Design System, the Digital Transformation Office citied other successful government design systems around the world as their inspiration, one of which, was the GOV.UK Design System from the United Kingdom's Government Digital Service [11]. As such, taking an analytical look at the

Canada.ca Design System with respect to the British GOV.UK Design System aids in providing greater context the state of Canada's design system efforts.
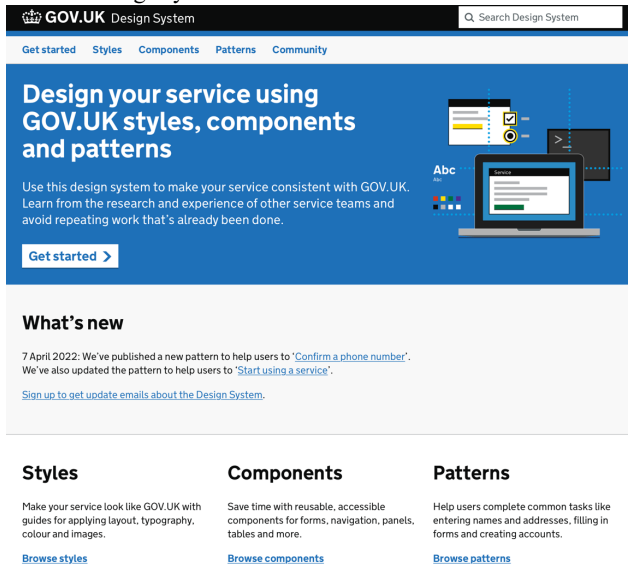

Figure 4: A screenshot of the GOV.UK Design System documentation.

The GOV.UK Design System (located at design-system.service.gov.uk) easily meets all minimum requirements for a design system, as set out in Section 2.1.1. It has its own philosophy/ethos [15], it includes pattern/component libraries, (which have sample code, usage guidance, warnings against incorrect use and various user experience pitfalls, as well as instructions on how to best implement each given pattern or component), and has its own content style guide all accessible in a singular "system" [16].
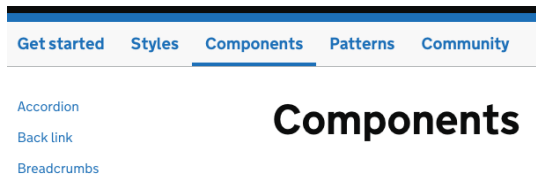

Figure 5: A screenshot of the GOV.UK Design System's separation of documentation.

Compared to the Canadian Canada.ca Design System, it quickly becomes apparent that the GOV.UK Design System is a lot more mature, well developed and well thought out. The system includes 31 individual components, and 28 user researched design patterns, marking a total of 59 combined components and patterns (compared to the Canada.ca Design System's 41 combined components and patterns). Additionally, the system's documentation separates between, "styles", "components", and "patterns" in its guide (whereas the Canada.ca Design System combines these aspects), this separation helps distinguish between reusable UI elements themselves and the contexts/tasks (patterns) they're able to be used in (for example, using a text input

component could be used to ask for a SIN numbers or full names, which are patterns) [16].

Within each component or pattern, the guidance provided is like that of the Canadian Design System (when to use the component or pattern, when to avoid it, code examples, etc..), however, there is often an additional section available entitled "Research on this component/pattern" under each component or pattern. This section often cites user-tested research done by the Government Digital Service (for example, click-through rates on some button colours) [17], or industry published research (for example, the W3C conventions on asking user's their names) [18]. This overall, helps users of the design system better understand the user-testing behind design decisions and can help lend greater legitimacy to the advice/conventions provided by the design system. This section also does appear in the Canada.ca Design System, however, it appears to be available on a smaller number of components.

Lastly, the GOV.UK Design System appears to encompass guidance on a greater number of "standard" components used on the web (as well as on other mediums) compared to the Canada.ca Design System. These components include, but are not limited to, file upload elements, text input fields and selection boxes [16]. The Canada.ca Design System, compared to the GOV.UK Design System also lacks pattern guidance on things such as names input, phone number input, gender, or sex input, etc.., all of which are regularly part of government forms & operations.

2.1.3. Government design systems (GOV.UK & Canada.ca) compared with industry design systems.

Since the use of design systems, in large part, were first adopted by and popularized in private industry prior to making their way over to government institutions, it is useful to look at design systems use in government through comparison and analysis of how design systems are implemented and used within private industry.

While there are countless design systems created by corporations for use in their own products, there are a handful few that can be considered industry trendsetters or industry standards, i.e., those with the most significant reach of users, these design systems, through their application in various products possess the ability to standardize expectations of interaction behaviours. For the purposes of this comparison, Google's Material Design, which, through its use in Google's Android operating system, reaches upwards of 3 billion devices [19], marks itself as an excellent candidate.

The Material Design System is the most evolved out of the Canadian and British design systems. It very easily meets and surpasses our criteria listed in Section 2.1.1, it includes 30 reusable components, and 56 defined interaction patterns, as well content guidelines. It also includes guidance for mediums that are not present in both government systems such as, machine learning/automated systems, auditory systems, and sensory systems [20]. It should be noted, however, numerical comparisons aren't very useful as many included components and patterns likely won't be needed by government design systems, but despite this, there are still a few other shortcomings to note.

When accessing individual components in the design system, each component includes much of the same information as the two government design systems, including implementation and research details, however, there is an additional section to note missing from both design systems: specifications [21].

Each component includes a specification section, in-which dimensions and specifications for each components design are listed. This helps users of a design system who are implementing it on a platform that is not included in the sample code to do so with ease, be able to replicate a component to the pixel level. Given that design systems are meant to be portable, and generic enough to be applied to various platforms and mediums, this is an important addition, which should be added to both government design systems.

Additionally, both the Canadian and the UK based design systems lack design pattern guidance for dark themes, as well as progress indicators, both of which are present in the Material Design System. Given that there has been a rising trend in the computing industry to include "dark mode" or "dark theme" options in operating systems, websites, etc., and given that data suggests that this inclusion is here to stay [22], (meaning that, as it becomes more ingrained, the more likely users will expect design systems to implement the pattern ubiquitously), it is imperative that government design systems also move to adapt this paradigm.

Progress indicators are also a very common design pattern and component used in modern web applications. With the continued rise and use of JavaScript based frameworks such as ReactJS to create Single Page Applications [23], it is more and more likely that modern government projects will adopt the technology eventually. Since Single Page Applications do not rely on a browser's in-built loading indicators, it is important for design systems to have a consistent experience when performing loading actions.

It's clear that compared to private industry-based design systems, such as Material, that both the Government of Canada and Government of the United Kingdom's design systems aren't as full featured. Much of this limitation is due to their limited application scope, however, both design systems still could adopt a few items from the Material Design System (such as dark mode design patterns, specification guides, etc.) which would result in an overall net-benefit to these design systems.

2.2 SUGGESTED IMPROVEMENTS TO THE CANADA.CA & GOV.UK DESIGN SYSTEMS

Given the analysis in the previous section, there are several additions and improvements would be beneficial to both the Canada.ca Design System and the GOV.UK design system.

Both GOV.UK & Canada.ca Design System would benefit from:

- The addition of a "dark mode" or "dark theme" design pattern to help aid in future-proofing the design systems are the pattern becomes increasingly normalized and expected.

- The addition of a progress indicator component. Given the rise of ReactJS and other Single Page Application frameworks. Reliance on the browser's in-built loading indication is diminished, and the inclusion of a purpose-built component will be required.

The Canada.ca Design System would benefit from:

- The inclusion of more "standard" UI components such as file upload, phone number input, etc.

- The addition of design pattern guidance on names input, phone number input, gender input, SIN Number Input, etc. (like the UK system has), because these fields appear often on government applications.

- Greater separation between "patterns" and "components" to help aid in making the design system more readable and generic.

3 PROBLEMS FACING THE PROGRESSION OF DESIGN SYSTEMS IN GOVERNMENT

Governments are complex organizations, adopting new practices, especially those which require an agile way of operating, can be extremely difficult and require deep intuitional change. Government technology initiatives don't have the same level of flexibility as their private sector counterparts due to their unique position in society, which means the adoption of changes to initiatives like design systems, which, are meant to be continuously evolved poses challenges.

Governments often have difficulty in acquiring user feedback and doing user research and testing, due to government regulations and mandates which may limit the ways in which governments may do so [24]. Additionally, many governments run websites which involve various ministries and may be cross-jurisdictional, meaning that performing A/B testing, or other user-centered design strategies becomes increasingly complex due to obligations to various stakeholders [24]. Additionally, government websites often contain time-sensitive, and time-critical information, some of which could be life-changing for citizens using them, as such, they must be increasingly mindful of even simplistic changes to websites and web applications.

Some governments have been able to successfully navigate through this challenge, including the creators of the GOV.UK Design System, the Government Digital Service (GDS). GDS operates with reduced bureaucratic overhead, smaller teams, and an overall more agile workflow [25]. This reduction of overhead has allowed them to quickly iterate through services and improve the GOV.UK Design System through quick iterations and user feedback. This unfortunately, however, has not been the case for the Government of Canada, which is still plagued with non-agile attitudes and approaches to government technology initiatives. These approaches often require designers and developers within the Government of Canada to write tens of thousands of words of documentation and obtain multiple levels of clearances to facilitate the launch of new online services for user feedback [25].

While it is to be expected for governments to ensure that their technology initiatives are created in a way that is easily trackable, effective, safe, and secure, too much overhead can hinder progress, and set back projects which are designed to be quickly iterated upon, such as design systems.

Unfortunately, the solutions to this issue are complex, multifaceted, and likely beyond the scope of this paper.

CONCLUSION

Overall, this paper aimed to act as a primer to design systems, their history and what a "design system" is defined as. It additionally, aimed to explore design systems within the governmental context, specifically exploring the design system offered by the Government of Canada.

It compared the Government of Canada's design system with other governmental offerings and those in private industry to gain a better understanding of the current state of the design system. Through these comparisons, it was found that, while the Canada.ca Design System is a relatively well featured, and well thought out, there are several improvements which can be made to bring the system on par with its governmental peers. In respect to private industry, both it and its governmental peers fell short on implementing certain design patterns and components which were considered standard in private industry design systems.

Lastly, the paper briefly touched on limiting factors of innovation and improvement to agile government initiatives such as design systems, the root causes of these factors were found to be institutional.

ACKNOWLEDGMENTS

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